Cartographic Visualization of Census Data for the State of Texas

GRADUATE PROJECT

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by

Reena Sodiny
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Committee Members

Dr. Dulal C. Kar
Committee Chairperson

Dr. Joseph C. Loon
Committee Member

Joseph C. Loon

Dr. Long-zhuang Li
Committee Member

ABSTRACT

In the context of geospatial data handling, the cartographic visualization process is considered to be the translation or conversion of geospatial data from a database into maps. This process is guided by “how to say what to whom, and is it effective?” applying cartographic methods and techniques such as choropleth maps, classification, color, etc.

In this project a tool has been developed to display interactive cartographic maps for the state of Texas. The maps interactively provide various demographic data for the state of Texas. This tool can be used by any user for the purpose of comparing different census data across different counties for the state of Texas.

This project was developed as a three tier application with a geospatial database as the data source/data provider, a middle business/logic layer which consumes the data and does the data transformation, and a user interface layer that displays the generated interactive maps to the user. The software displays interactive maps with demographic information for the state of Texas. The software provides county wide information on population, population density, number of housing units, and male/female ratios. Detailed information about each county can be obtained just by the click of a button.

The software provides additional functionality to import shapefiles into a geospatial database and to display the same as maps. These maps can be added as layers one over the other. So two different shapefiles can be imported and can be seen as a single map by adding two different vector layers. The user is allowed to add any column from the database as a label over the map thus providing functionality for easy data visualization.

The project was developed using Microsoft Visual Studio 2005 as the IDE. Visual Basic .net was used as the programming language. PostgreSql was used as the database. PostgreSql was chosen because of its support for the geospatial databases. ArcMap was used to create shapefiles for the state of Texas with the related demographic data.

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1. INTRODUCTION AND BACKGROUND

Maps are simplified representations of reality. This partly is done for convenience since it becomes very difficult to draw and interpret multiple information themes on one map covering more than a very small area. Before computers became widely available, thematic maps on plastic Mylar sheets could be laid on top of each other, revealing more information about an area than was possible with any single paper map. The amount of data that could be represented on such maps was very limited and also there was no way to link the information related to the map to the map itself [James 2001].

Currently there is no existing application for the custom specific settings of the proposed Texas census geodatabase and cartographic visualization. Recently a project titled “Design and Implementation of a User Friendly Geodatabase System for the State of Texas” [Uppala 2006] has been implemented which retrieves the population data from a database and presents it as reports rather than having it on a map so that users can visualize and interact with it. Demographic data when presented as interactive maps can provide more information to the user both for informational and data analysis purpose.

In order to use the program designed in this project one does not need to know ArcGIS. The designed program makes it easy to map data for the state of Texas.

1.1 GIS and Cartographic Visualization

A geographic information system (GIS) is an information management system for archiving, retrieving, analyzing, and visualizing data referenced by spatial or geographic coordinates. A GIS acts as an integrating technology that helps to store and retrieve information based on where they are physically located [Anderson 2003]. GIS technology incorporates common database operations with the unique visualization and spatial analysis advantage offered by maps.

GIS has evolved out of a long tradition of map making. Over the years GIS has evolved through multiple parallel but separate applications across numerous disciplines. Maps are simplified representations of reality. This partly is done for convenience since it becomes very difficult to draw and interpret multiple information themes on one map covering more than a very small area.

The development of the Geographic Base File/Dual Independent Map Encoding (GBF-DIME) files by the U.S. Census Bureau in the 1960s marked the large-scale adoption of digital mapping by the government [GISHISTORY 1997]. A grid-based mapping program called SYMAP [Chrisman 2004], developed at the Laboratory for Computer Graphics and Spatial Analysis at the Harvard Graduate School of Design in 1966, served as a model for later systems [Chrisman 2005]. These early GIS packages were often written for specific applications and required the mainframe computing systems found usually in government or university settings. In the 1970s, private vendors began offering off-the-shelf GIS packages. M&S computing (later Intergraph) and Environmental Systems Research Institute (ESRI) emerged as the leading vendors of GIS software [James 2001].

1.2 Cartographic Visualization

Cartography plays an important role in the graphical presentation of geospatial information. The cartographic visualization process involves translation or conversion of geospatial data from a database into maps applying cartographic methods and techniques.

In other words principles from cartography and geographic information systems are integrated in the development and presentation of georeferenced information.

Translation of data from a geospatial database and presenting it as a graphical map is the most efficient and effective means of presenting the data to the user. Presenting data as maps enables the user to locate geographic objects on the map. Different colors, shapes, and signs can be used to inform the user about the characteristics of a particular place on a map, i.e. a location on the earth.

Cartographic maps were designed by taking into account the information that can be presented through the maps, since the nature of the data determines the graphic options. For example, a gradient map with different colors can be used when presenting data like population density while lines of different types can be used to represent rivers and roads.

1.3 Geodatabases

A geodatabase is a storage mechanism for spatial and attribute data. It contains collection of features, attributes and, relationships between features. All geodatabases, whether personal or ArcSDE can store tables, feature classes, feature datasets and so on.

Geodatabases are grouped into two different types: vector and raster. Vector data is represented using points, lines and polygons [GISLOUNGE 2005a]. Figure 1.1 is an example of polygon dataset with thematic color mapping.

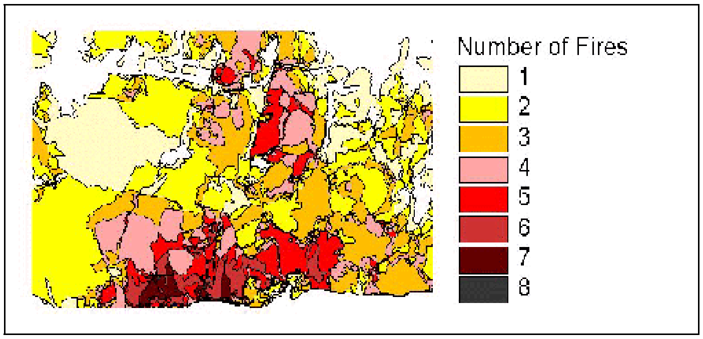


Figure 1.1 Polygon dataset depicting the frequency of fires [GISLOUNGE 2005a]

Raster data is represented as a surface divided into a regular grid of cells. There are three types of raster datasets: thematic data, spectral data, and image data [GISLOUNGE 2005b]. Figure 1.2 is an example of a thematic raster dataset also called a Digital Elevation Model (DEM).

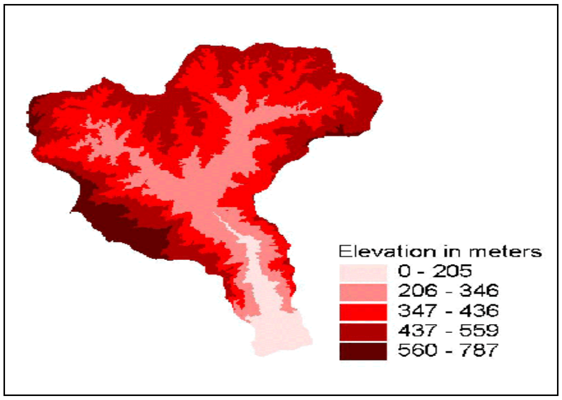


Figure 1.2 Thematic raster dataset [GISLOUNGE 2005b]

1.3.1 Representation of a Geodatabase

The geodatabase provides the common data access and management framework for ArcGIS that enables us to deploy GIS functionality and business logic wherever it is needed in desktops, servers, or mobile devices [ESRI 2005]. Figure 1.3 represents the geodatabase architecture. With this architecture the user has the tools to assemble data for geographic information systems [ESRI 2005]. The geodatabase is a common framework shared by all ArcGIS products and applications.

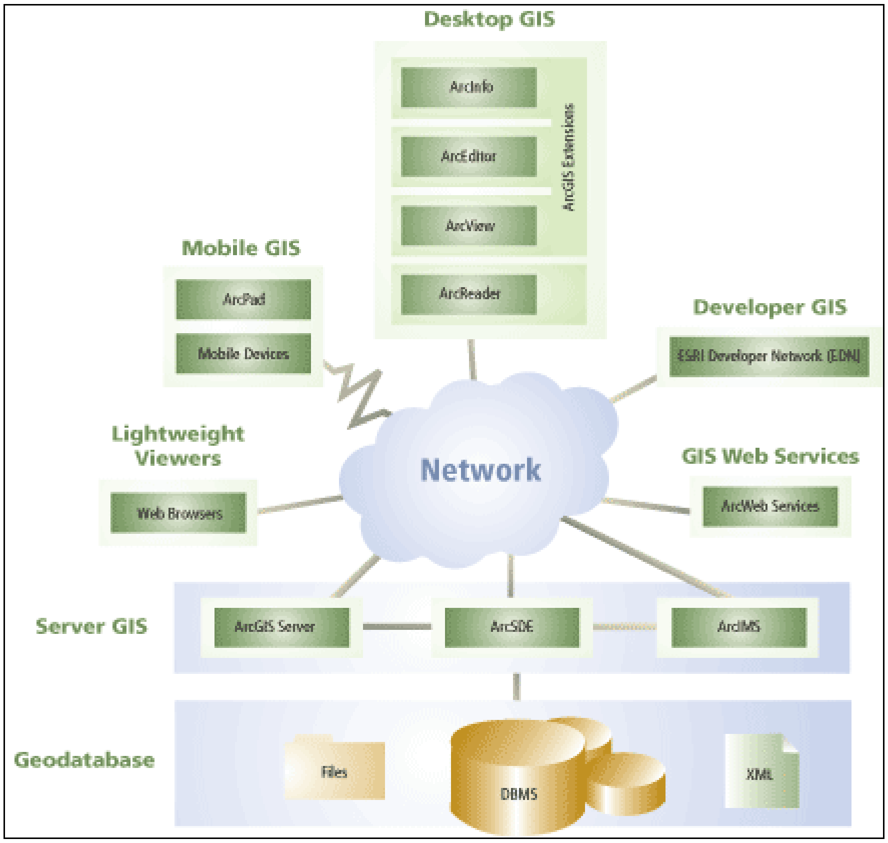


Figure 1.3 Geodatabase architecture [ESRI 2005]

1.4 Existing System

A Project titled “Design and Implementation of a User Friendly Geodatabase System for the State of Texas” [Uppala 2006] has been implemented which retrieves the population data from a database and presents it as reports. The application is data driven and all the data is stored and retrieved from a database. The application presents a clickable map for the state of Texas which can be used to update and retrieve the required information. The information for each county can be retrieved and updated by clicking on the respective county of the map.

1.4.1 Problems with the Existing System

The existing system retrieves the population data from a database and presents it as reports. Any census data presented in the form of reports is hard to visualize and comprehend. Census data can be easily visualized when presented on the map. This also helps in comparing the data for the various regions of the map.

Comparing census data between the different regions becomes difficult when the information is presented as reports. If a comparison has to be made then data for each region to be compared has to be either saved to files or printed out before comparing. This is difficult but possible if there are only few regions to compare but when all the data across the state has to be compared this becomes impossible.

1.5 Project Goals

The major goal of the project is to present data extracted from a geospatial database in the form of interactive maps. In order to realize this goal a number of preliminary steps have to be performed including converting and loading data into the database. The following goals have been realized.

- Convert and load data from shapefiles into a data format that can be stored in a geospatial database.
- Read the data from the database and present it as interactive maps with data from the database.
- Allow the user to create any map on the fly with data retrieved from the database.
- Allow the user to add vector layers to a map with data obtained from different data sources and presenting all the information in a single map.

1.6 Project Report Organization

The next section (Section 2) presents the narrative of the scope and accomplishments of the project. Section 3 presents the design and implementation of the project, including database design and implementation of the user interface. Section 4 discusses the testing procedures adopted to test the project for any bugs. A discussion of future work related to this project is discussed in section 5. Section 6 includes the conclusions derived from this project.

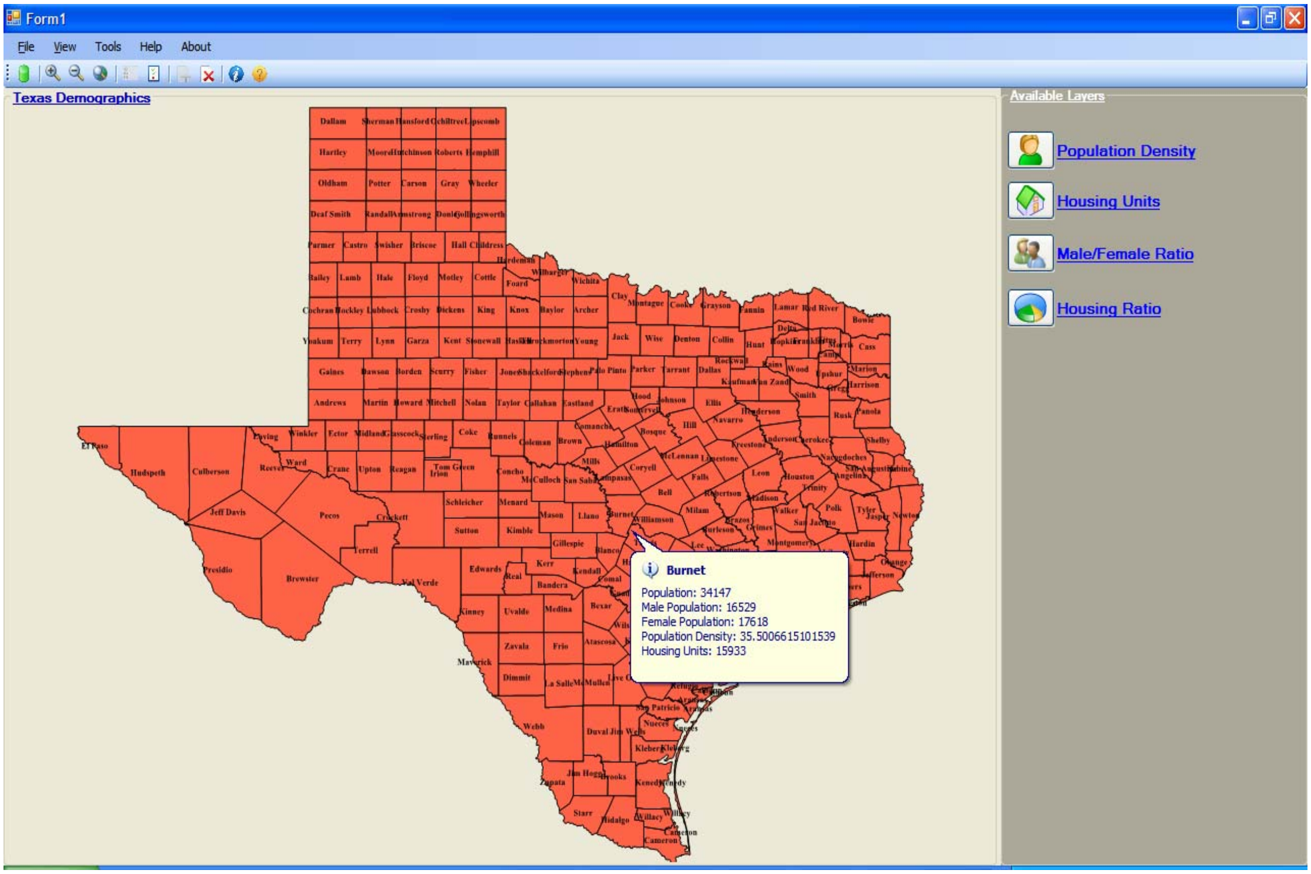
2. CARTOGRAPHIC VISUALIZATION OF CENSUS DATA FOR THE STATE OF TEXAS

Cartographic Visualization for the State of Texas is a windows forms application designed using Visual Studio .net 2005. The two main components of the project are a geospatial database designed and implemented in PostgreSql, and a front end to present the data as maps. The project utilized GIS technologies in creating census datasets for state of Texas. The front end user interface of the project has three major components:

- Interactive map for the state of Texas that shows census data for the state of Texas.
- Data upload tool that helps convert any kind of shapefile into a format that can be stored to a spatial database. This data can be later used to generate maps on the fly.
- Maps can be generated on the fly from the data stored in the database. Data from different tables can be added as layers and can be seen on a single map allowing us to combine data from various sources into a single map.

2.1 Interactive Maps with Census Data

This part of the project focused on creating an interactive map for the state of Texas. The map shows county wise census data. Data like total population, population density, and number of housing units are shown for each county. In addition functionality is provided to create thematic maps for showing population density, and number of housing units in each county. Maps with pie charts are also provided to show such ratios as male to female ratios in each county. Figure 2.1 shows a simple map with census data that shows up when the mouse is moved over any particular county.



Burnet

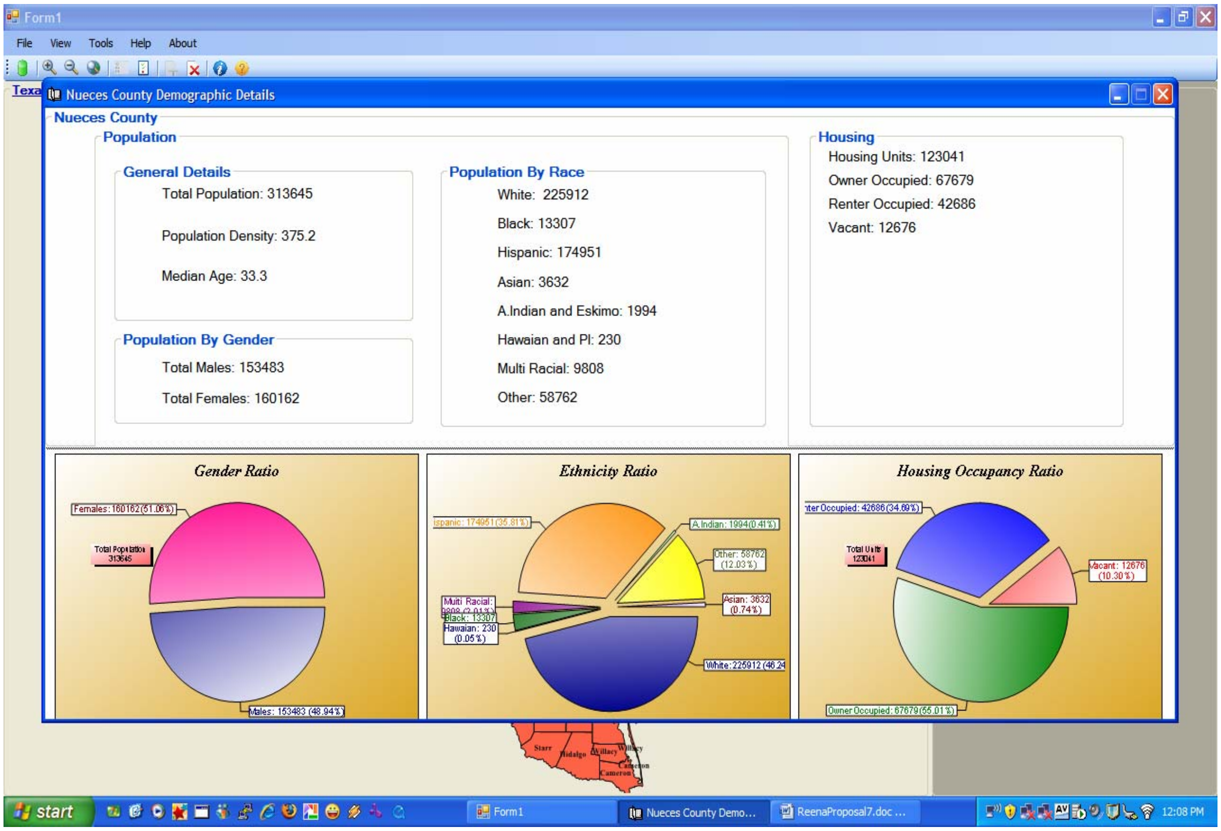
Population: 34147
Male Population: 16529
Female Population: 17618
Population Density: 35.5006615101539
Housing Units: 15933

Figure 2.1 Interactive map showing census data

The software provides various controls to the user to view and change the map. The following tools are available to the user to control how the map is shown and to control what data is displayed on the map.

- Zoom In: The Zoom In control lets the user to zoom in to the map to see each area more clearly.

- Zoom Out: The Zoom Out control lets the user make the map smaller. When a user zooms in if the map is too big then he/she can use the Zoom Out tool to make the map smaller.
- Zoom to Extents: This tool can be used to redraw the map to its original size.
- Pan: Panning is bringing a particular area of the map into focus. The map can be panned by right clicking and dragging the map to any location.
- Show/Hide Labels: These tools can be used to show or hide the county names on the map.
- Show/Hide Tooltip: Census data for each county is displayed as a tooltip. This tooltip can be shown or hidden using these controls.
- Detailed Data: Double clicking on any county brings up a new screen that shows the census data and various graphs for that particular county. Figure 2.2 shows detailed data view for Nueces County.



Nueces County

Population

General Details

Total Population: 313645

Population Density: 375.2

Median Age: 33.3

Population By Gender

Total Males: 153483

Total Females: 160162

Population By Race

White: 225912

Black: 13307

Hispanic: 174951

Asian: 3632

A.Indian and Eskimo: 1994

Hawaiian and PI: 230

Multi Racial: 9808

Other: 58762

Housing

Housing Units: 123041

Owner Occupied: 67679

Renter Occupied: 42686

Vacant: 12676

Figure 2.2 Detailed census data

2.1.1 Thematic/Gradient Maps

The links on the right in Figure 2.1 allow the user to access thematic/gradient maps showing the population density, and the number of housing units in each county. Such data can be used to compare the data across different counties. Figure 2.3 shows a thematic map for the population density for the state of Texas. All the controls such as the Zoom in, Zoom out, and access to the detailed county wise data are also available through these maps.

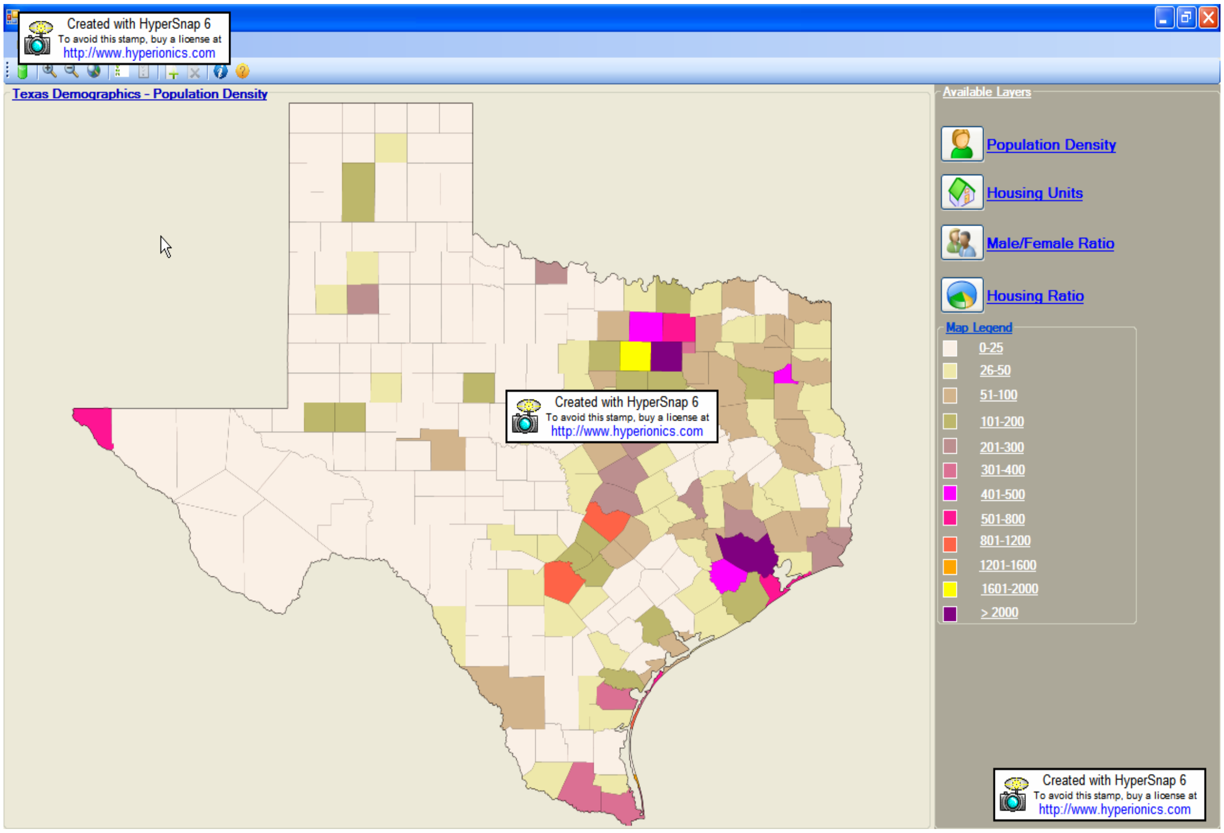


Figure 2.3 Thematic map showing population densities

2.1.2 Maps with Pie Charts

Data such as the male/female ratio, and the ratio of housing units which are owner occupied versus renter occupied versus vacant units are shown on maps with pie charts. Figure 2.4 shows a map with the male/female ratios for various counties. The map in the figure has been zoomed in to show the graphs clearly.

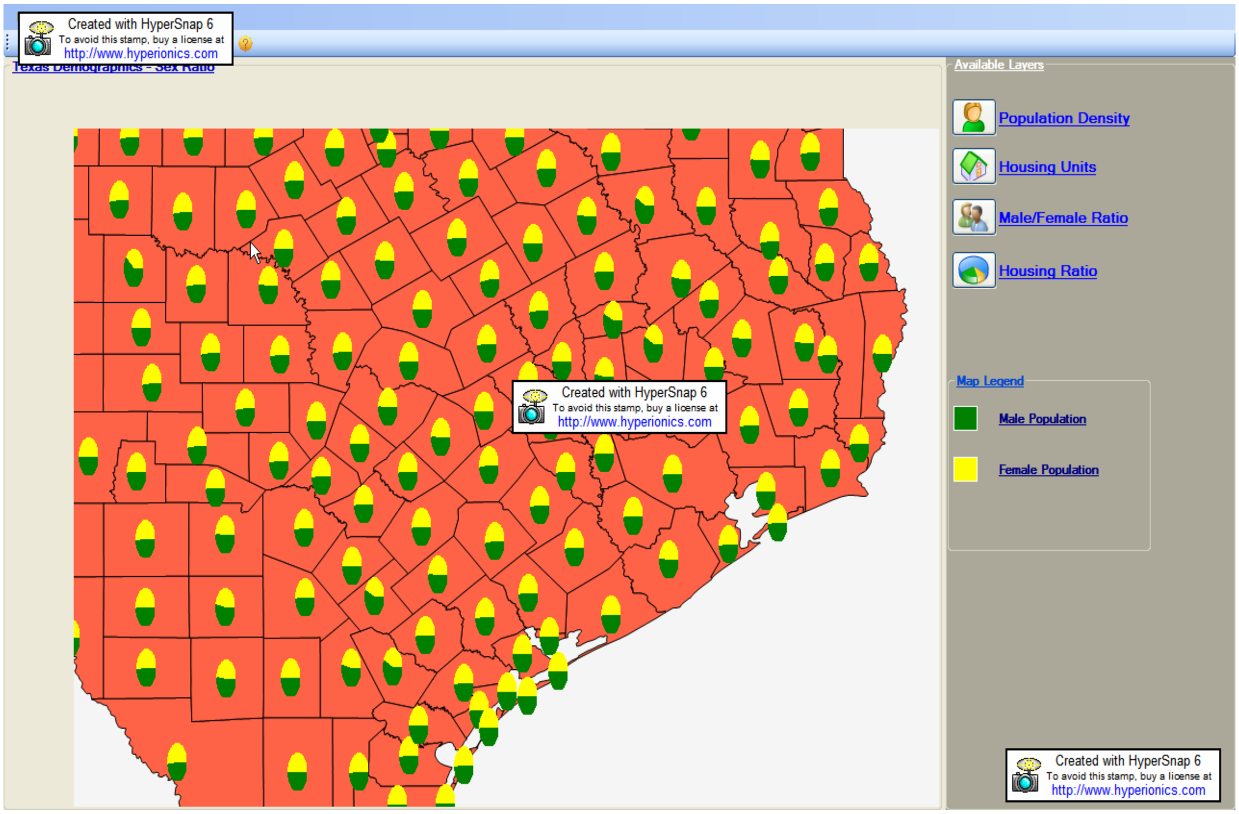
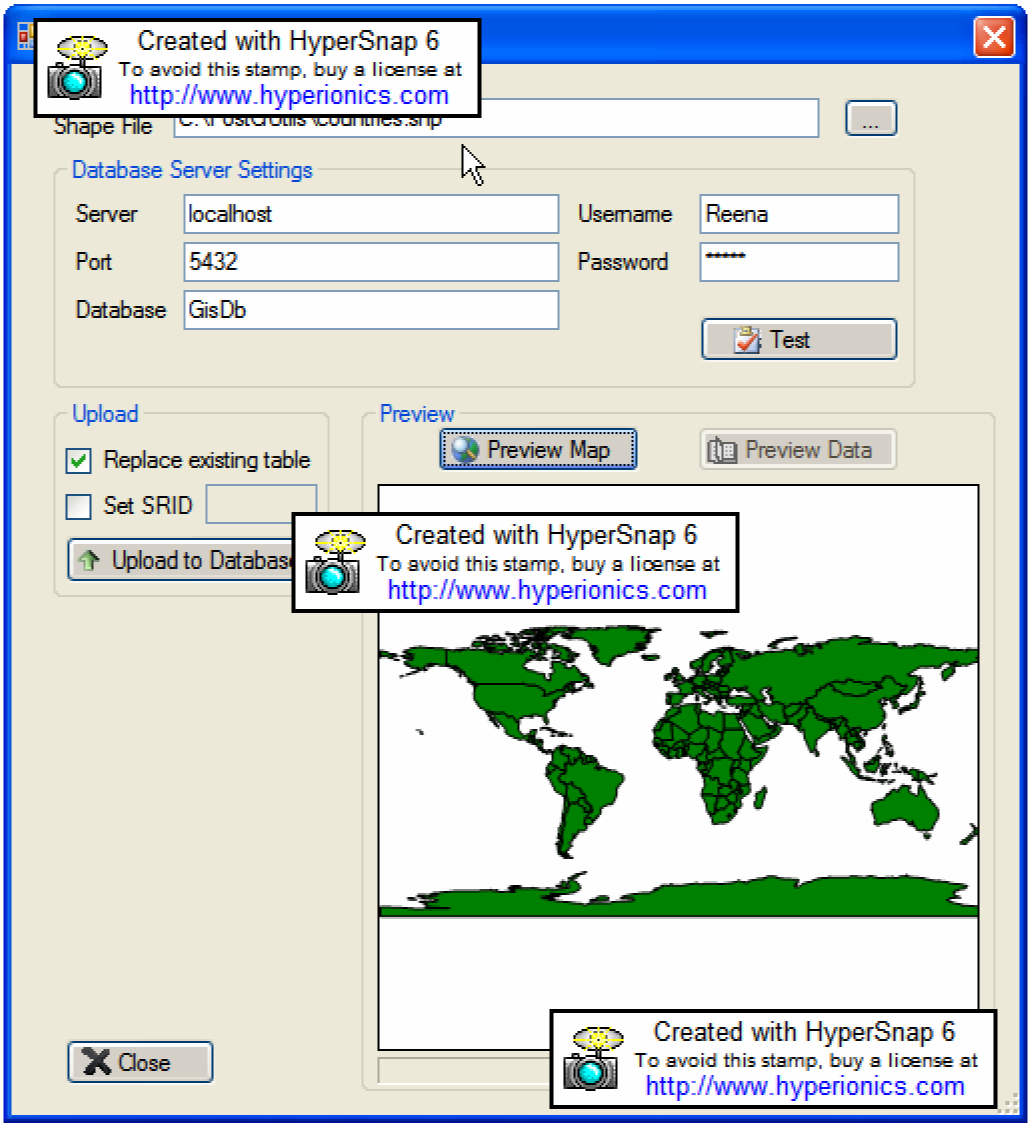


Figure 2.4 Map with pie charts showing male/female ratios

2.2 Converting Shape Files to GeoSpatial Data

The software has a built-in tool to convert any given shapefile to a format that can be imported into a geospatial database. The user needs to specify the name of the shapefile to be converted and the name of the destination database. The software creates a new table in the user specified database with the same name as the shapefile and import all the relevant data into that table. A new table is created for every shapefile imported. The user needs to have permissions to create new tables in the specified database. The connection to the database with the user credentials can be tested before proceeding further. The software provides the user with tools to preview the data in the shapefile so that the user can know beforehand what is being imported. Figure 2.5 shows the data conversion tool in action.



Shape File C:\PostGrOtis\countries.shp

Database Server Settings

Server localhost

Port 5432

Database GisDb

Usemame Reena

Password ******

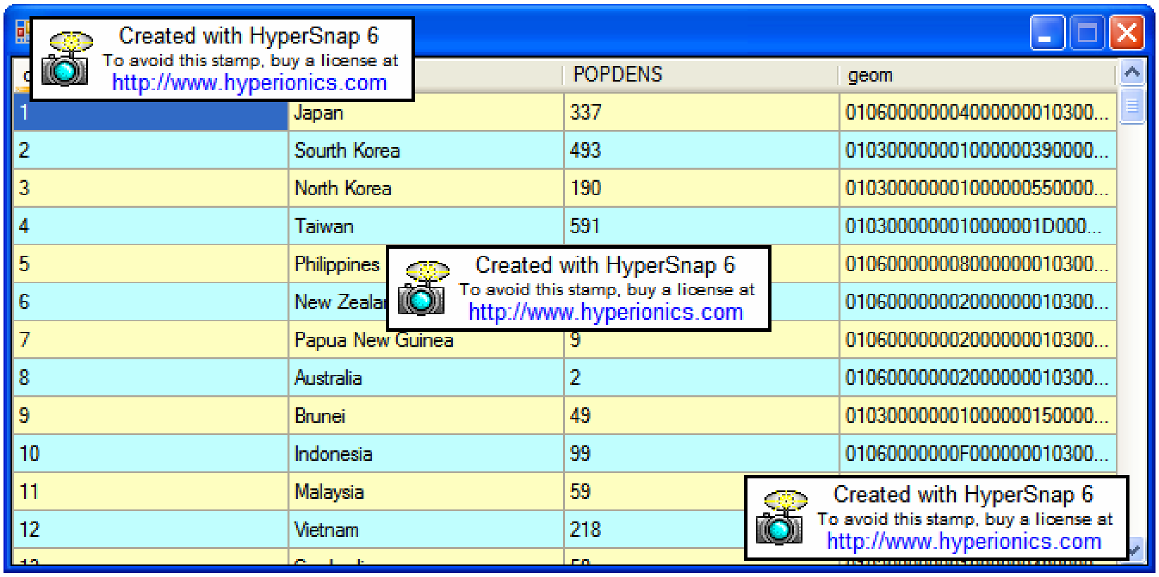
Upload

☑ Replace existing table

□ Set SRID

Figure 2.5 Data conversion tool

After previewing the data the user can click the ‘Upload to Database’ button to start the conversion and import process into the database. After the data has been successfully imported the user can open the data from the tool as if he/she has opened the newly created table in the database. Figure 2.6 shows the table after the data has been imported into the database.

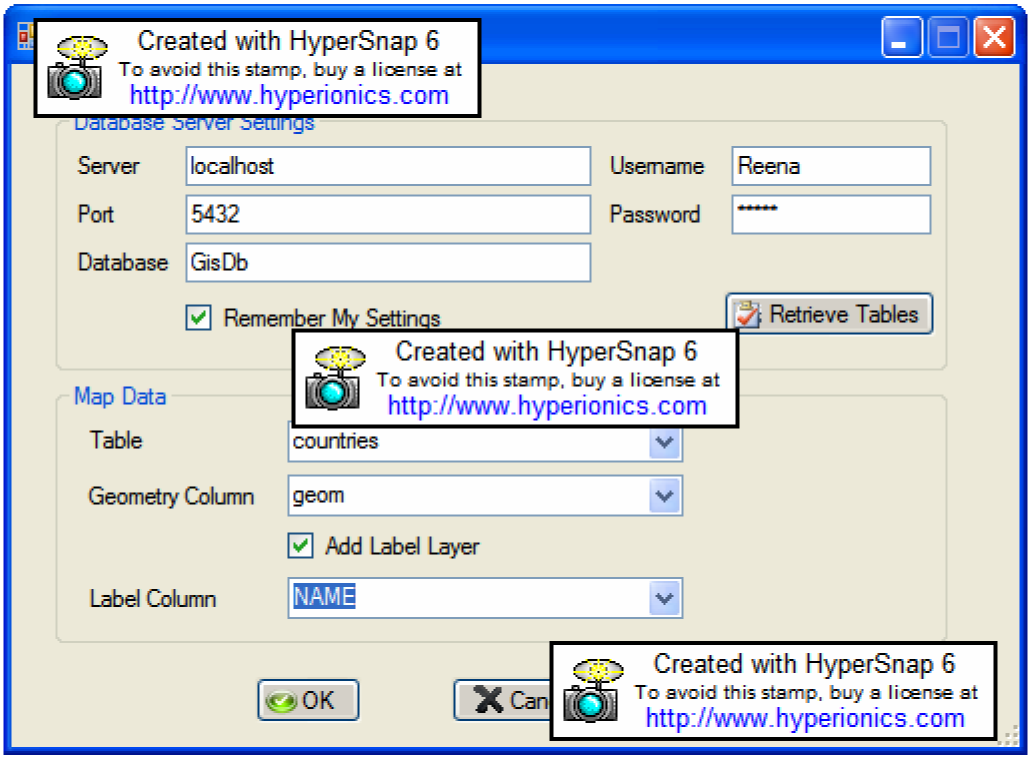


c		POPDENS	geom
1	Japan	337	01060000000400000010300...
2	Sourth Korea	493	01030000000100000390000...
3	North Korea	190	01030000000100000550000...
4	Taiwan	591	0103000000010000001D000...
5	Philippines	[illegible]	01060000000800000010300...
6	New Zeala	[illegible]	01060000000200000010300...
7	Papua New Guinea	9	01060000000200000010300...
8	Australia	2	01060000000200000010300...
9	Brunei	49	01030000000100000150000...
10	Indonesia	99	0106000000F000000010300...
11	Malaysia	59	[illegible]
12	Vietnam	218	[illegible]

Figure 2.6 Data preview pane

2.3 Creating New Maps

Data imported in the previous section can be used to create new maps. Labels specifying the map regions or any other labels can be added to the map by specifying the columns in the database tables. New Vector layers can be added to the existing maps thus creating a map with the required details. For example a shapefile with country boundaries can be converted to geospatial data and can be added as a new map and another layer with data about the rivers can be added as a vector layer to the map thus creating a new map which shows all the rivers in the world. Figure 2.7 shows the process of adding a new map. After specifying the database settings, clicking on the ‘Retrieve Tables’ button retrieves all the existing tables in the database. The user can then select any table that he/she wishes to add as a new map. If the user wishes to add labels to the map the user needs to specify the column whose data will be used as labels over the map.



Database Server Settings

Server: localhost

Port: 5432

Database: GisDb

Username: Reena

Password: *****

☑ Remember My Settings

Created with HyperSnap 6
To avoid this stamp, buy a license at
http://www.hyperionics.com

Map Data

Table: countries

Geometry Column: geom

☑ Add Label Layer

Label Column: NAME

Created with HyperSnap 6
To avoid this stamp, buy a license at
http://www.hyperionics.com

Figure 2.7 Add new map

Figure 2.8 shows the result of adding a new map. Controls can be used to Zoom In and Zoom Out and perform other operations. Figure 2.9 shows the same map with a new vector layer with rivers data added to the map.

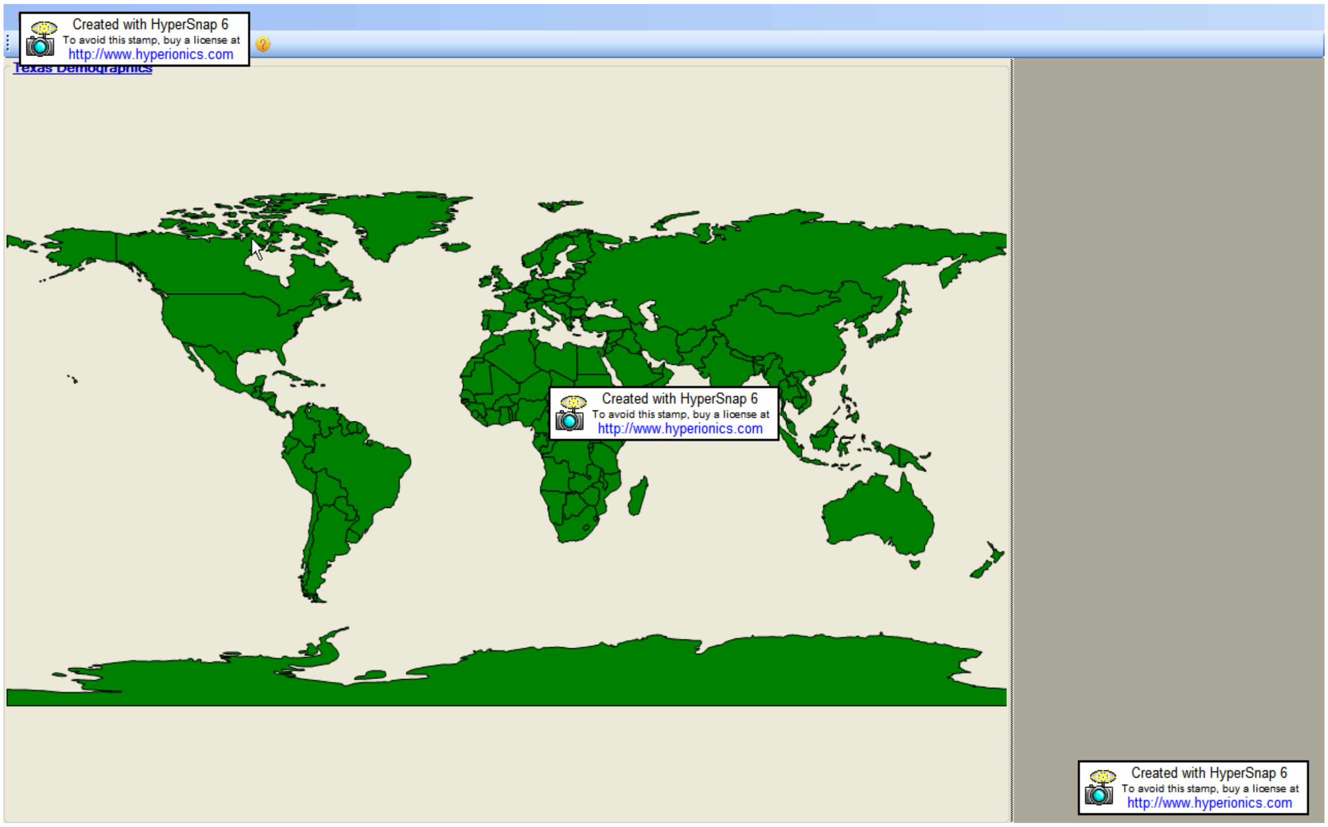


Figure 2.8 Result of adding a new map

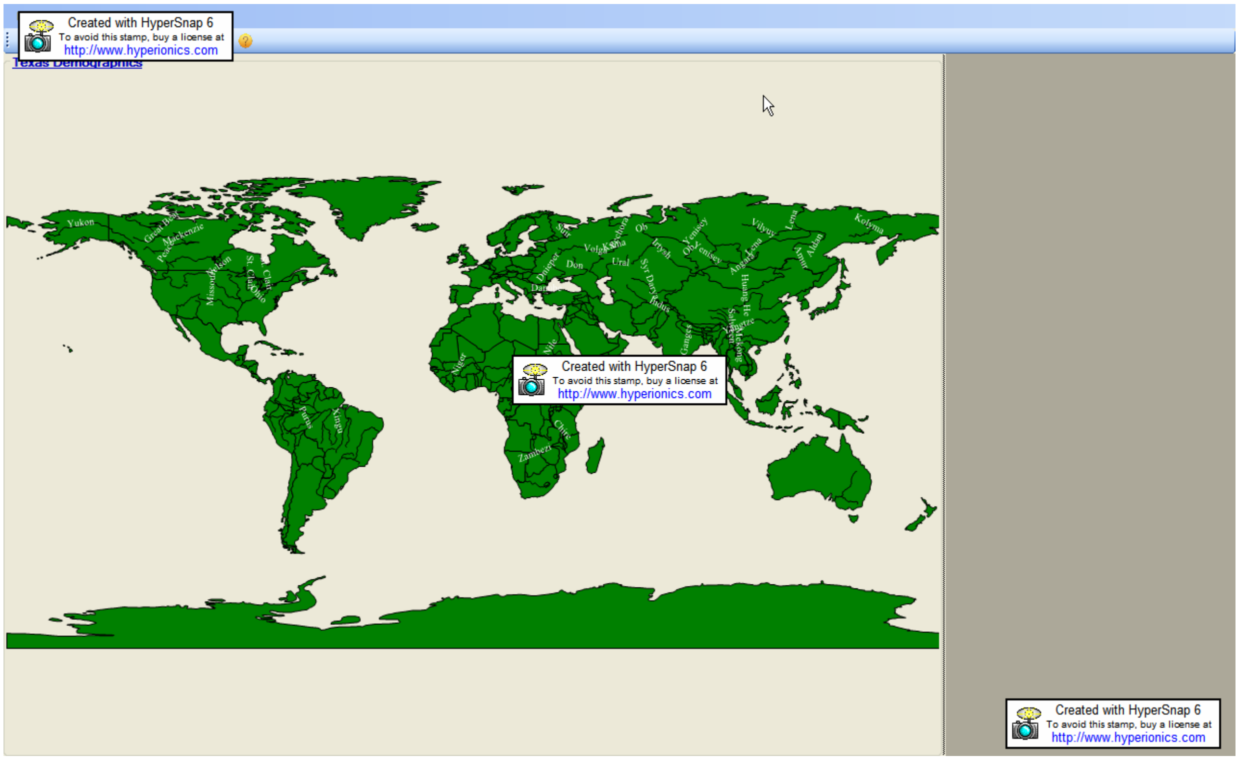


Figure 2.9 Resulting map after adding a new rivers layer

3. SYSTEM DESIGN

A Windows forms based GIS application for creating and displaying interactive maps with Texas census data was developed in this project. The system incorporates GIS and database technologies to provide an interactive mapping application for displaying census data for the state of Texas. The software also provides tools to convert data from shapefile format to a format that can be stored in a database. Finally the software enables the user to create maps from geospatial data retrieved from the database.

3.1 Geodatabase Design

The first phase of the project involved the design of a geodatabase system. A geodatabase is a relational database that stores geographic data [ESRI 2005b]. It may thus be described as a container for storing spatial and attribute data and the relationships that exist among them. A geodatabase provides a technique for representing real world geographic features and attributes as objects in a database, and is hosted inside a relational database management system (RDBMS) [Zeiler 2004]. The design of the geodatabases generally starts with the thematic layer. Designing a geodatabases can be divided in to three phases [Arctur 2005]. They are 1) Conceptual design phase, 2) Logical design phase and 3) Physical design phase. Figure 3.1 illustrates the three phases of Geodatabase design.

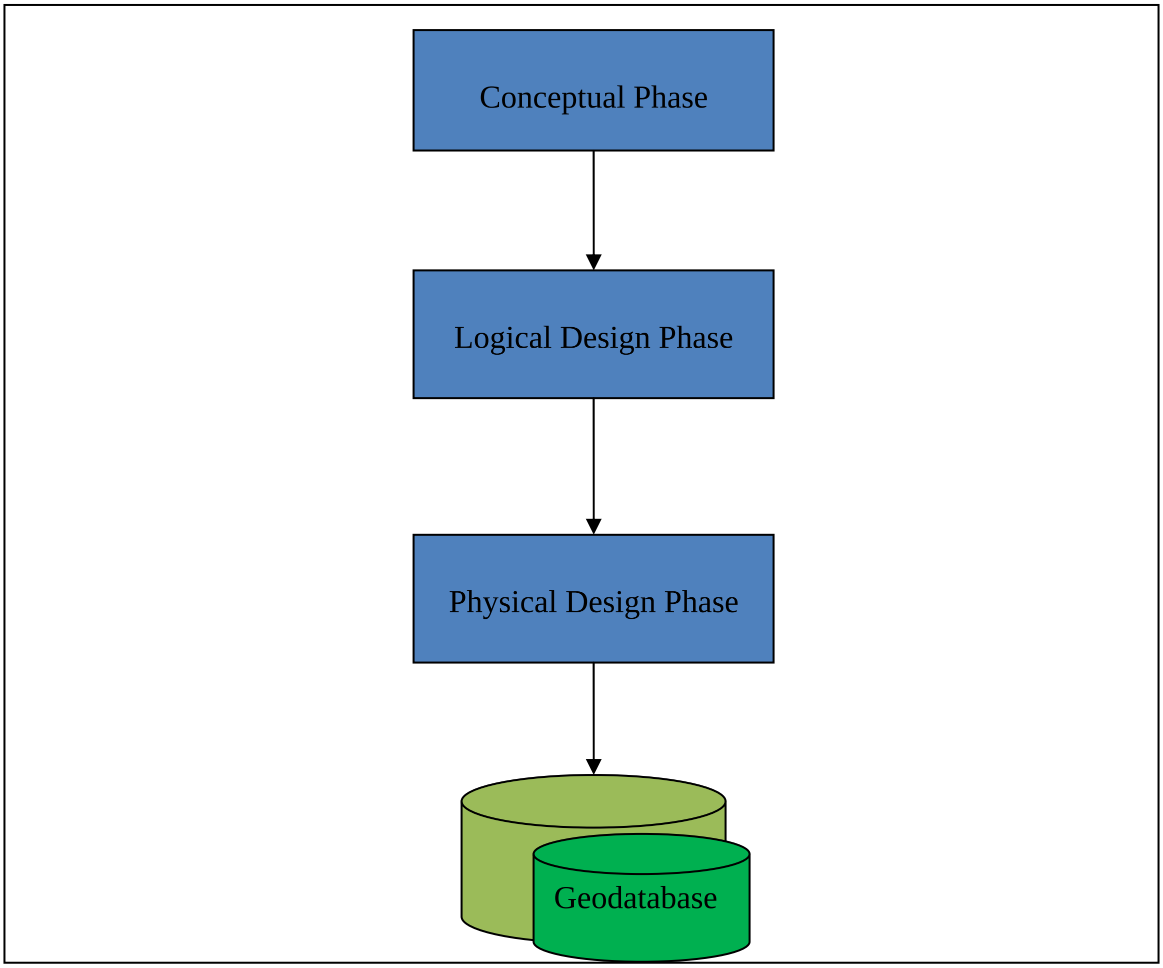


Figure 3.1 Stages of geodatabase design

The major activities performed in the development of the census geodatabase include the following:

- Identify the database system that is suitable to store the GIS data and is free of cost. For this project PostgreSql was a suitable choice with its rich support for storing GIS data.
- Geodatabase Design.
- Geodatabase Implementation.

3.1.1 PostgreSql

PostgreSql was used as the geospatial database in developing this project. PostgreSql is an open source Relational Database Management System (RDBMS). PostgreSql has rich object oriented features such as inheritance, polymorphism and the ability to create complex user defined datatypes. PostgreSql has the built-in ability to process the spatial datatypes, called geometry or feature. All these features make PostgreSql an ideal candidate for storing and retrieving geospatial data. In order for PostgreSql to store GIS related spatial data an extension called PostGIS has to be added and enabled in PostgreSql. PostGIS adds support for geographic objects to the PostgreSql object-relational database. In effect, PostGIS creates a spatially enabled PostgreSql server, allowing it to be used as a backend spatial database for GIS.

3.1.2 Design and Implementation

The census data has two principal components. They are geographic mapping data of the physical features and tabular population data. Once the data is obtained, then managing, correcting and updating the collected data are major tasks. Because of the extensive use of census data both by private and public organization, the data model was developed to enable the user to put the data to maximum use. The main design issues of the census data model were designing the thematic layer framework, geodatabases structure, census topology, rules for the census topology, census boundaries, linking census demographic statistics, and deciding on the administrative units.

Data for this project was obtained from various sources and in different formats. Geographic mapping data of the physical features of the state of Texas was downloaded from the ESRI web site in the format of a shapefile. The census data is usually is in the form of tabular format. Census data was obtained in summary file format from the ESRI web site. The two sets of data were merged using ArcMap software to create a new shapefile. Figure 3.2 shows the process of obtaining and loading the census data into the GIS database. The following steps were performed in ArcMap to create a new shapefile:

- The shapefile with data of the county boundaries for the state of Texas was loaded into ArcMap.
- With the shapefile loaded the summary file with the demographic information was loaded into ArcMap.
- A join was preformed to join the demographic with the physical features for the state of Texas. A join relates the attribute data in the table to the geographic data layer by using a common attribute field.
- The file was saved as a shapefile.

This newly created shapefile has all the required information and was imported into the database with the data import tool that was developed as part of this project.

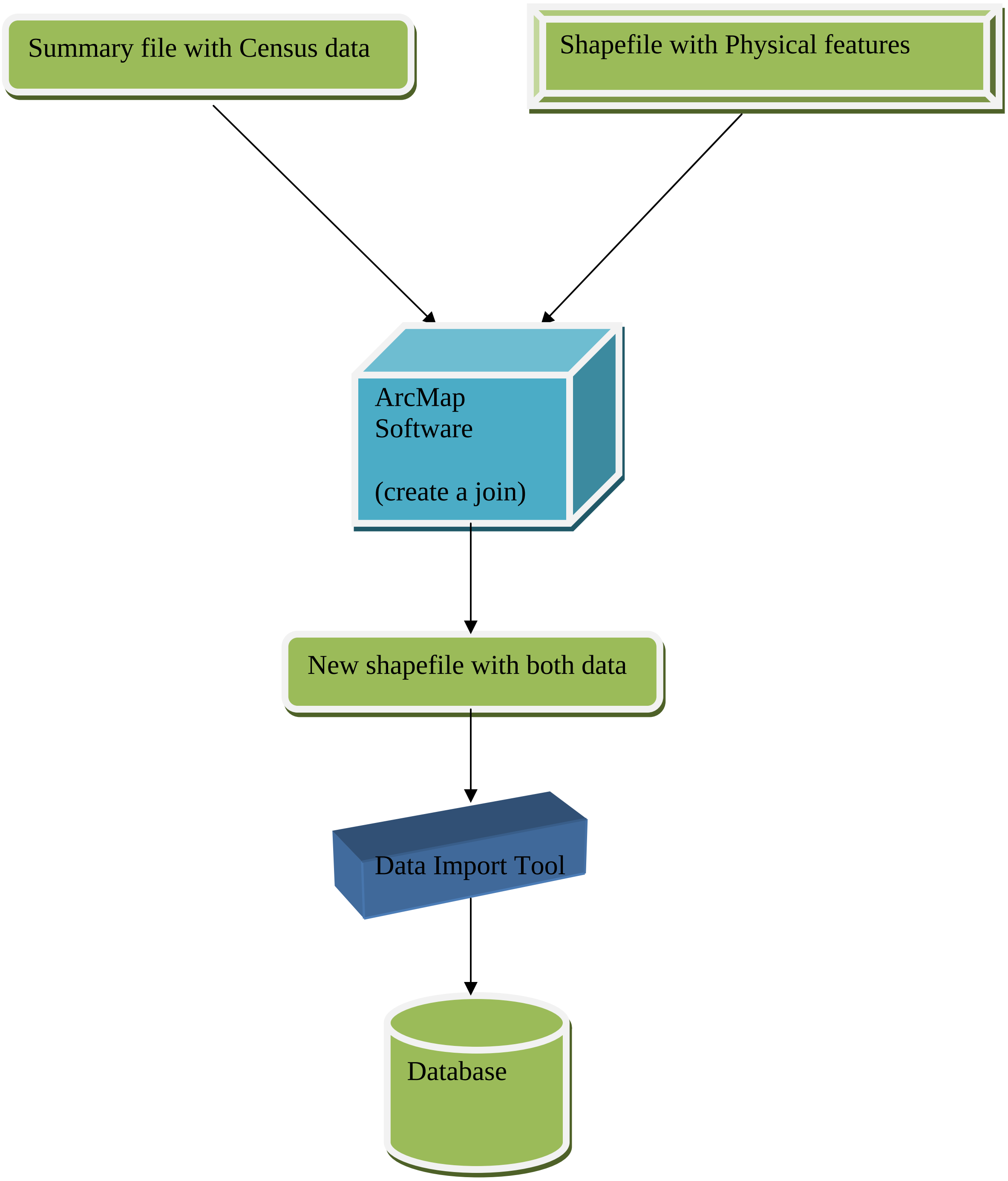

Summary file with Census data
Shapefile with Physical features
ArcMap
Software
(create a join)
New shapefile with both data
Data Import Tool
Database

Figure 3.2 Data processing and loading

3.2 User Interface Design

The user interface for implementing the project was designed using Microsoft Visual Studio 2005. The application was programmed using Visual Basic .NET. The application was designed as a three tier application with a data access layer dealing with accessing data from the geodatabase, a middle logic/business layer transforming and computing data to a format suitable for display by the front end user interface. Figure 3.3 shows a basic design of the application. Microsoft® ActiveX® Data Objects .net (ADO .net) was used in the data access layer to retrieve the data from the database. ADO .net enables the client application to access and manipulate data from a variety of sources through an OLE DB provider. Its primary benefits are ease of use, high speed, low memory overhead, and a small disk footprint [MSDN 2004a].

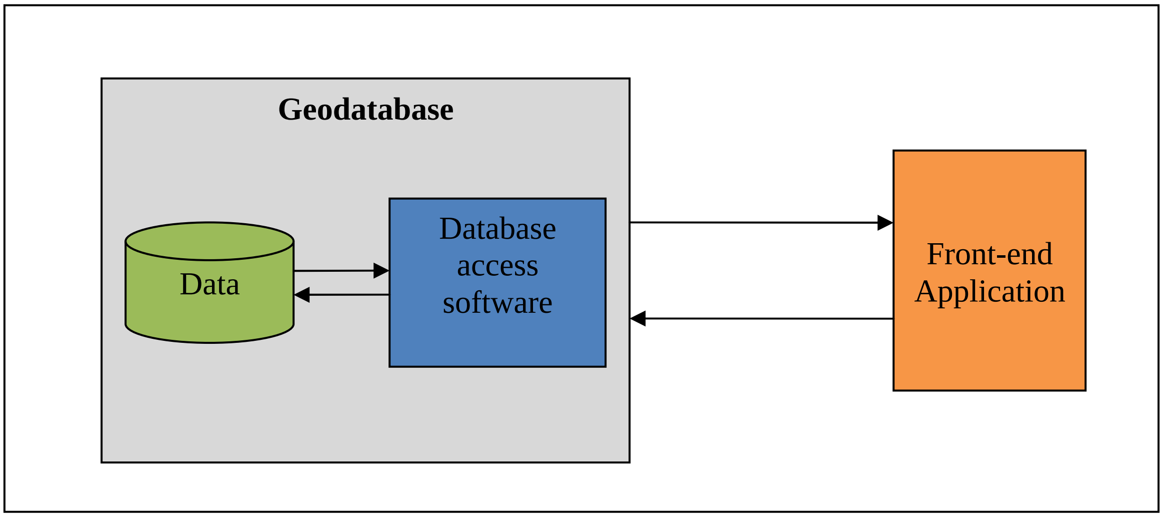


Figure 3.3 Design of the application [Stephens 2002]

3.2.1 Design and Implementation

This section discusses the technical details of the code implementation. Various classes that are used for data access, generating maps, storing, and retrieving user settings etc. are discussed. This discussion focuses mainly on the functionality of core classes.

3.2.1.1 App.Config File

Microsoft .net environment provides an easy way to store and retrieve application and user settings. Application wide settings like the database connection strings, and user settings like the color preferences, language etc. can be stored in a central repository file called *App.Config.* Just a couple of lines of code is all that is needed to retrieve these settings. While the application settings are Read-Only, the user settings can be written to thus allowing the application developer to store any user preferences in the *App.Config* file.

The current project uses the *App.Config* file to store database connection string and certain user settings. The database connection string is stored as an application setting which has application wide scope. User settings are used to store the user credentials to access the database. Since more than one user can use the same computer and each user has his/her own set of credentials to access the database, these settings are stored with a user scope. Table 3.1 shows the application and the user settings stored in the *App.Config* file.

Table 3.1 Application and User settings in *App.Config* file

Setting	Scope	Value

ConnString	Application	Driver={PostgreSql};Server=127.0.0.1;Port=5432;
		Database=GisDb;Uid=Reena;Pwd=*****;

Database	User	GisDb
Port	User	5432
Server	User	Localhost
UserName	User	
Password	User	

The code fragment below shows a way to access the ConnString application settings stored in the *App.Config* file:

```
Dim Connection as string ‘ declare a variable as string
Connection = My.Settings.ConnString ‘ read value from App. Config
```

3.2.1.2 GenerateMaps.vb

This is one of the core classes that are vital for the functionality of the application. GenerateMaps.vb class is designed to create interactive maps with census data for the state of Texas. This class has several properties that can be used to either set or retrieve that any of the class private variables. This class provides methods to generate different kinds of maps and to manipulate the generated maps. The class provides methods to hide and show the labels, hide and show the tooltip etc. Table 3.2 shows the methods provided by this class and the functionality of each method.

Table 3.2 Methods available in the GenarateMaps.vb Class

Method Name	Function
InitializeMap	Creates a new empty map
AddLabels	Adds labels showing the map regions
GetLabelLayer	Return the label layer
GradientMap	Creates a thematic map
Male/femaleRatioChart	Create a map with pie charts showing male/female ratio
HousingRatioChart	Create a map with housing ratios

3.2.1.3 Shape2Spatial.vb

This class is used to convert any shapefile to a data format that can be imported into a GIS database. This class uses the GenerateMaps.vb class to generate a preview map from the shapefile.

3.2.1.4 DbSettings.vb

This class is used to gather the database information from the user when the user wants to create a new map. This Class exposes a public event that is raised after the user has finished entering all the required information. This event is caught in the calling class and necessary steps are taken to generate a new map.

4. TESTING AND EVALUATION

This section describes testing procedures employed to test the project for errors. Software testing is the process used to help identify the correctness, completeness, security and quality of developed computer software. Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design and code generation [Pressman 2001]. A set of testing schemes were used to test the functionality and usability of the application. Testing was done both during the project development (unit testing) and after the application has been completely developed. To minimize the number of defects unit testing was done during the application development. Each part was tested individually to test the correct functionality. Once the application has been developed completely all the individual parts of the application were integrated and integration tests were performed.

4.1 Functional Testing

Functional testing was performed throughout the life cycle of the project. The objective of the functional testing is to verify how well the system performs [Pressman 2001]. The various functions the project is supposed to execute were tested. User commands, data manipulation tools, map generation, map navigation tools of the system were tested. Any errors found during Functional testing were corrected before adding any new features to the software.

The next phase of testing was functional verification testing that was done by the users who were explained the scope and the functionality of the project. Five testers who work at Computer Services at Texas A&M University-Corpus Christi were involved in testing the application. The testers are computer savvy and have some programming knowledge but none of the testers is knowledgeable about GIS related concepts. The testers did not have knowledge of the internal workings of the applications but just what the application is supposed to do and the expected results. During this test phase each of the testers were assigned to test different functionality of the application. The testers were provided with test cases that describe in detail what the tester needs to do and how to do it. The test case also showed the expected outcome of the process. The tester then performed the action and verified the outcome with the outcome described in the test case. Any defects found were documented and fixed.

After all the defects found in the functional verification testing have been fixed, the final phase of testing was performed. This was done to ensure that all the defects have been fixed and also to ensure that the new fixes have not created any new bugs in the application. Table 4.1 shows the results of Functional testing.

Table 4.1 Functional Testing Results

Test Phase	Module Tested	Number of Test Cases	Number of Defects
Phase 1	Texas Census	8	2
	Data Conversion	4	0
	New Maps	10	2
Phase 2	Texas Census	8	0
	Data Conversion	4	0
	New Maps	10	1

4.2 Usability Testing

Usability testing is used to identify how users actually interact with the application. The application was tested for the ease of navigation through the forms, appearance, and consistency.

Appearance: All the forms were checked for the uniformity in the appearance.

Ease of navigation: The application was tested to see if there are any links that break the application and made sure that all the links are properly connected to the required pages.

Consistency: The application was tested for the consistency of the data that is being displayed on the pages. Table 4.2 shows the results of usability testing. The results in the table show that the application meets the usability requirements. All the usability criteria were rated 5 out of a maximum score of 5 except for the look and feel.

Table 4.2 Usability Testing Results

Usability Metric	Score (Out of 5)
Ease of Use	5
Look and Feel	4
Colors and Fonts	5
Ease of Navigation	5
Features	5

5. FUTURE WORK

This project has some scope for enhancement in the future. The following are some of the ideas that can be incorporated into this project in future.

- Data: More data need to be presented in an easy to present manner. Presenting a lot of data on a map clutters the map defeating the main purpose. A better way needs to be implemented to show all the available data for a given map.
- Charts: The look and the information presented on the Pie charts shown on the maps have to be improved. New features can be implemented to increase size of the chart to a certain extent when zooming in to the map.
- User Preferences: There is a scope to allow the user to select the background colors for each map and the colors for the new layers and labels.

6. CONCLUSION

The design of the project is aimed at understanding the design principles and practices involved. The software can be used to view the census data for the state of Texas in an interactive manner. The software provides the user with a lot of flexibility in viewing and analyzing the census data. Population densities and the number of housing units across different counties can be compared by the click of a button. Detailed census data for a desired county is only a button click away.

The software provides a tool to convert any shapefile into a format that can be stored in a GIS database. This will help the available data to more use. Also new maps can be generated from different shapefiles imported into the GIS database.

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APPENDIX A – APPLICATION CONFIGURATION SETTINGS

```
<?xml version="1.0" encoding="utf-8" ?>
<configuration>
  <configSections>
    <sectionGroup name="applicationSettings"
type="System.Configuration.ApplicationSettingsGroup, System, Version=2.0.0.0,
Culture=neutral, PublicKeyToken=b77a5c561934e089" >
      <section name="TexasDemographics.My.MySettings"
type="System.Configuration.ClientSettingsSection, System, Version=2.0.0.0,
Culture=neutral, PublicKeyToken=b77a5c561934e089" requirePermission="false" />
    </sectionGroup>
    <sectionGroup name="userSettings"
type="System.Configuration.UserSettingsGroup, System, Version=2.0.0.0,
Culture=neutral, PublicKeyToken=b77a5c561934e089" >
      <section name="TexasDemographics.My.MySettings"
type="System.Configuration.ClientSettingsSection, System, Version=2.0.0.0,
Culture=neutral, PublicKeyToken=b77a5c561934e089"
allowExeDefinition="MachineToLocalUser" requirePermission="false" />
    </sectionGroup>
  </configSections>
  <system.diagnostics>
    <sources>
      <!-- This section defines the logging configuration for My.Application.Log -->
      <source name="DefaultSource" switchName="DefaultSwitch">
        <listeners>
          <add name="FileLog"/>
          <!-- Uncomment the below section to write to the Application Event Log -->
          <!--<add name="EventLog"/>-->
        </listeners>
      </source>
    </sources>
    <switches>
      <add name="DefaultSwitch" value="Information" />
    </switches>
    <sharedListeners>
      <add name="FileLog"
           type="Microsoft.VisualBasic.Logging.FileLogTraceListener,
Microsoft.VisualBasic, Version=8.0.0.0, Culture=neutral,
PublicKeyToken=b03f5f7f11d50a3a, processorArchitecture=MSIL"
           initializeData="FileLogWriter"/>
      <!-- Uncomment the below section and replace APPLICATION_NAME with the
name of your application to write to the Application Event Log -->
      <!--<add name="EventLog" type="System.Diagnostics.EventLogTraceListener"
initializeData="APPLICATION_NAME"/> -->
    </sharedListeners>
  </system.diagnostics>
  <applicationSettings>
    <TexasDemographics.My.MySettings>
      <setting name="ConnString" serializeAs="String">
        <value>server=127.0.0.1;database=GisDb;User
Id=Reena;password=medha</value>
      </setting>
      <setting name="OledbConn" serializeAs="String">

<value>Driver={PostgreSql};Server=127.0.0.1;Port=5432;Database=GisDb;Uid=Reena;
Pwd=vijithar;</value>
      </setting>
    </TexasDemographics.My.MySettings>
  </applicationSettings>
  <userSettings>
    <TexasDemographics.My.MySettings>
      <setting name="Server" serializeAs="String">
        <value />
      </setting>
      <setting name="Port" serializeAs="String">
        <value>5432</value>
      </setting>
      <setting name="Database" serializeAs="String">
        <value />
      </setting>
      <setting name="UserName" serializeAs="String">
        <value />
      </setting>
      <setting name="Password" serializeAs="String">
        <value />
      </setting>
    </TexasDemographics.My.MySettings>
  </userSettings>
</configuration>
```

APPENDIX B – SAMPLE USE CASE

ToolTip and Label Functionality

1) Open the TexasDemographics Application from the shortcut on the desktop.

2) The Application should open with a blank texas map. **Yes No**

3) Click on View->Show tooltip

4) Move the mouse over the map. A tool tip should appear showing the data for that particular geographic location. **Yes No**

5) Now click on View->Hide tooltip.

6) Move the mouse over the map again. The tooltip should not be visible. **Yes No**

7) Click on View->Show Labels

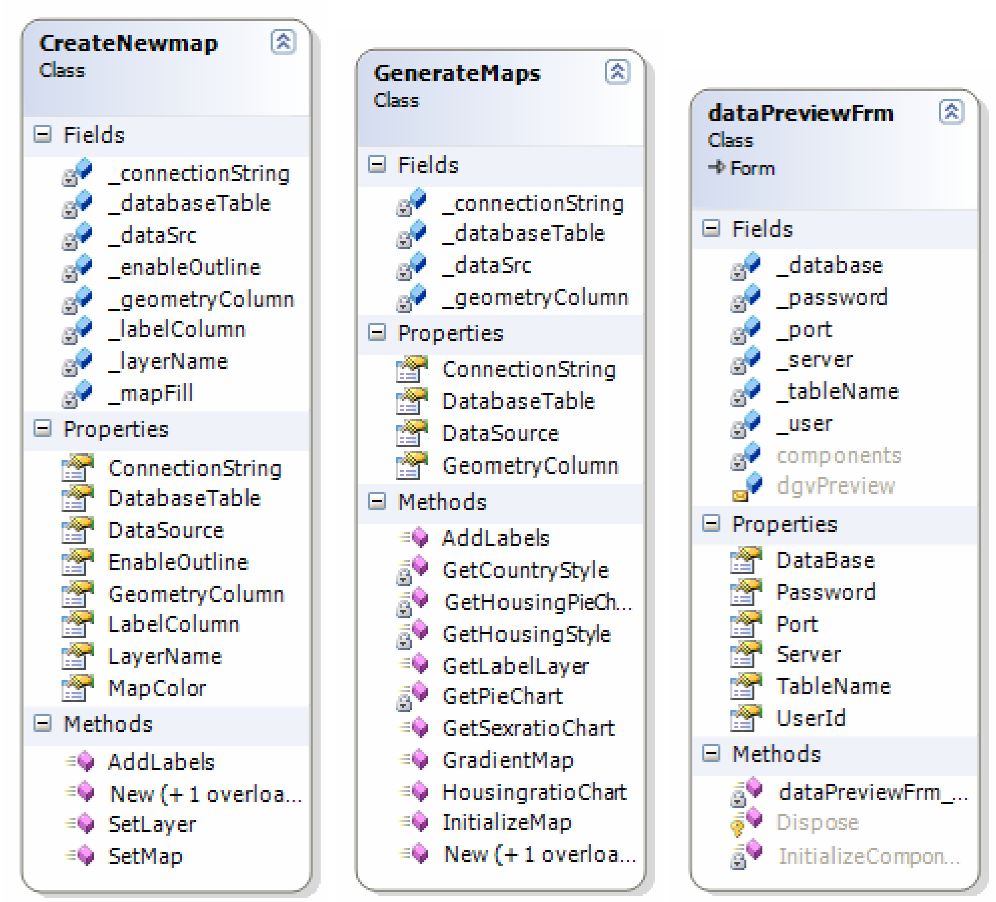
8) The map should now be generated with labels shown for all the counties. **Yes No**

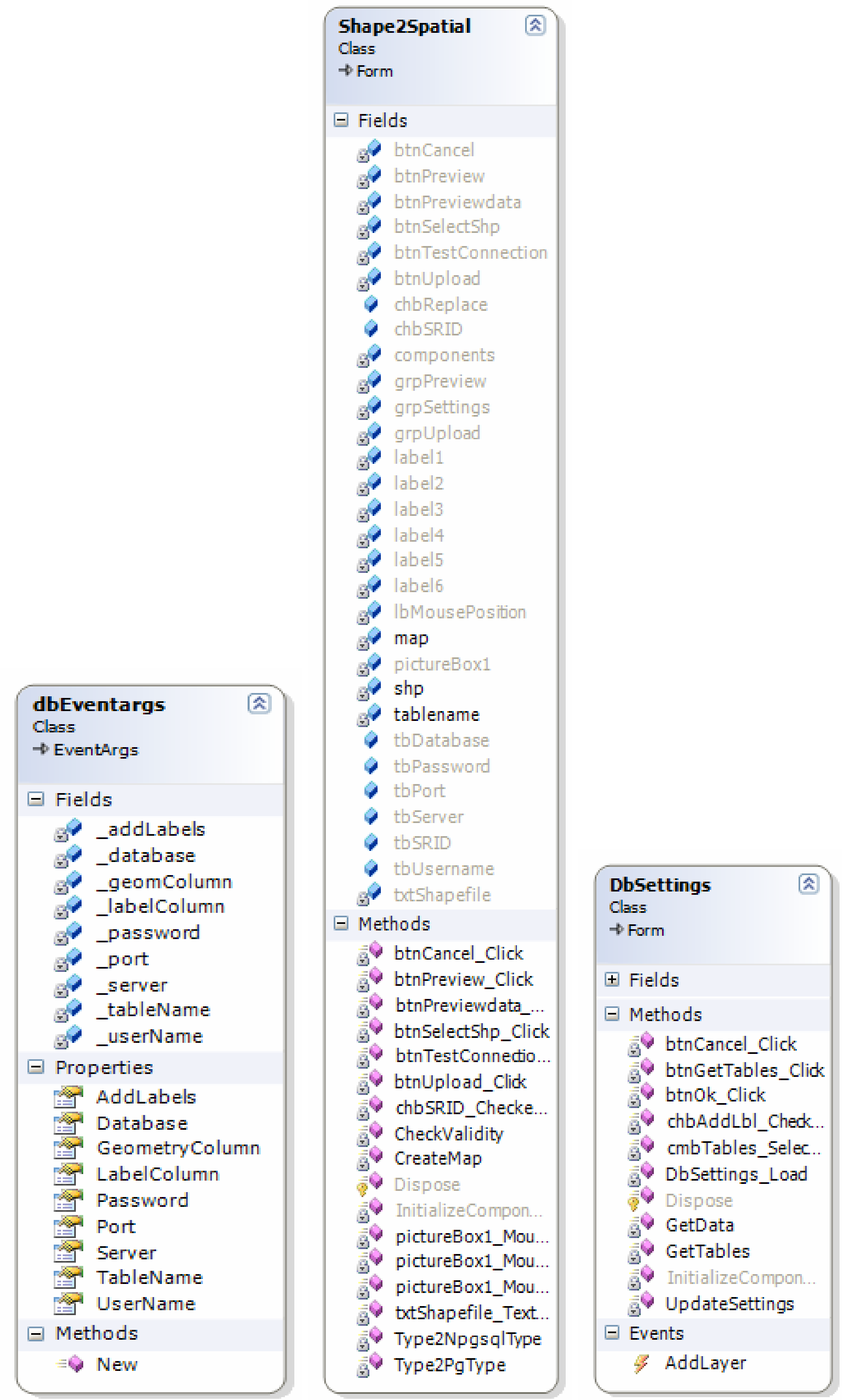
9) Click on View->Hide Labels

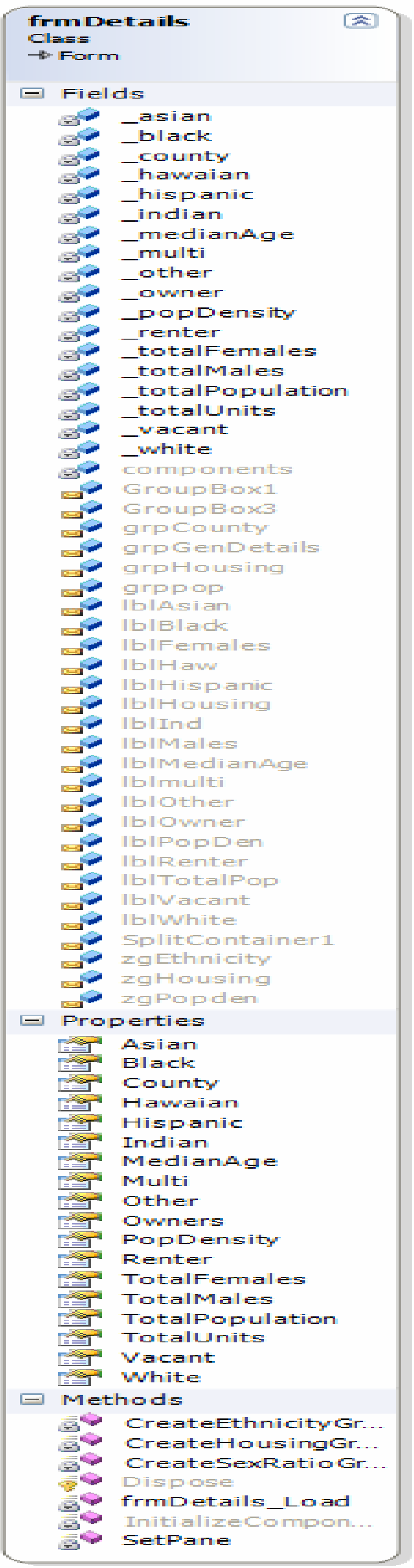
10) The labels should now be hidden **Yes No**

Remarks

APPENDIX C – CLASS DIAGRAMS




Shape2Spatial
Class
Form
Fields
btnCancel
btnPreview
btnPreviewdata
btnSelectShp
btnTestConnection
btnUpload
chbReplace
chbSRID
components
grpPreview
grpSettings
grpUpload
label1
label2
label3
label4
label5
label6
lbMousePosition
map
pictureBox1
shp
tablename
tbDatabase
tbPassword
tbPort
tbServer
tbSRID
tbUsername
txtShapefile
Methods
btnCancel_Click
btnPreview_Click
btnPreviewdata_...
btnSelectShp_Click
btnTestConnectio...
btnUpload_Click
chbSRID_Checke...
CheckValidity
CreateMap
Dispose
InitializeCompon...
pictureBox1_Mou...
pictureBox1_Mou...
pictureBox1_Mou...
txtShapefile_Text...
Type2NpgsqlType
Type2PgType
dbEventargs
Class
EventArgs
Fields
_addLabels
_database
_geomColumn
_labelColumn
_password
_port
_server
_tableName
_userName
Properties
AddLabels
Database
GeometryColumn
LabelColumn
Password
Port
Server
TableName
UserName
Methods
New
DbSettings
Class
Form
Fields
Methods
btnCancel_Click
btnGetTables_Click
btnOk_Click
chbAddLbl_Check...
cmbTables_Selec...
DbSettings_Load
Dispose
GetData
GetTables
InitializeCompon...
UpdateSettings
Events
AddLayer

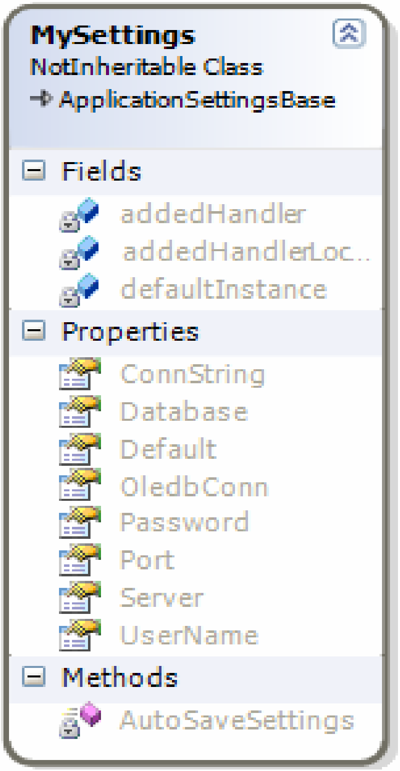


frmDetails
Class
→ Form

Fields
_asian
_black
_county
_hawaian
_hispanic
_indian
_medianAge
_multi
_other
_owner
_popDensity
_renter
_totalFemales
_totalMales
_totalPopulation
_totalUnits
_vacant
_white
components
GroupBox1
GroupBox3
grpCounty
grpGenDetails
grpHousing
grppop
lblAsian
lblBlack
lblFemales
lblHaw
lblHispanic
lblHousing
lblInd
lblMales
lblMedianAge
lblmulti
lblOther
lblOwner
lblPopDen
lblRenter
lblTotalPop
lblVacant
lblWhite
SplitContainer1
zgEthnicity
zgHousing
zgPopden

Properties
Asian
Black
County
Hawaian
Hispanic
Indian
MedianAge
Multi
Other
Owners
PopDensity
Renter
TotalFemales
TotalMales
TotalPopulation
TotalUnits
Vacant
White

Methods
CreateEthnicityGr...
CreateHousingGr...
CreateSexRatioGr...
Dispose
frmDetails_Load
InitializeCompon...
SetPane



MySettings
NotInheritable Class
→ ApplicationSettingsBase

Fields
addedHandler
addedHandlerLoc...
defaultInstance

Properties
ConnString
Database
Default
OledbConn
Password
Port
Server
UserName

Methods
AutoSaveSettings

APPENDIX D – USER MANUAL

Installation Instructions

The following are the main steps in installing and configuring the software.

- Install and Configure the database
- Populate the database.
- Install and configure the software.

Installing and Configuring the Database

Installation:

1. Use the CD provided and browse to the folder called Postgre and start the installation or Download the install for the Windows platform from the PostGreSQL Binary Download (http://www.postgresql.org/ftp/binary/) .
2. Make sure to check the PostGIS Spatial Extensions option, PgAdmin III, psql, option.
3. To access the database server from other than the local machine itself Check the "Accept connection on all addresses, not just localhost". This can be changed by editing the postgresql.conf -> listen_addresses property. The default port of 5432 can also be changed as well in the postgresql.conf -> port property.
4. For language check PL/pgsql. If you forget, you can later use the createlang plpgsql command to install in a specific database.
5. Enable contrib – Adminpack should be checked at the very least. This simplifies adminstrative management of the server via PgAdmin III.

Creating and Populating a Spatial Database

PostGreSQL comes packaged with an admin tool called PgAdmin3. PgAdmin III is under Start->Programs->PostGreSQL 8.2->PgAdmin III. Follow the steps below to create a new spatial database.

- Login with the userid and password set during install. Set the line

  host all all 127.0.0.1/32 md5
  to
  host all all 127.0.0.1/32 trust

  This will allow any person logging locally to the computer that PostGreSQL is installed on to access all databases without a password. (127.0.0.1/32) means localhost.

- Create your database. Call it GisDb (case sensitive).
- Use the PgAdmin III query tool to load the data into the GisDb database. To load the data open the Data.sql file included in the CD and copy the lines and paste them into the query tool and click on the 'Run' tool to populate the database.

Software Installation and Configuration

Use the CD to install the software. The installation should be pretty straight forward. Follow the instructions on the wizard to install the software.

Once the software is successfully installed locate the file called 'TexasDemographics.exe.config'. Use any text editor to open the file and locate the line that says "ConnString". This is the database connection information. Replace this line with the appropriate values. The server value corresponds to the name or IP address of the server on which the database was installed in the previous steps. The

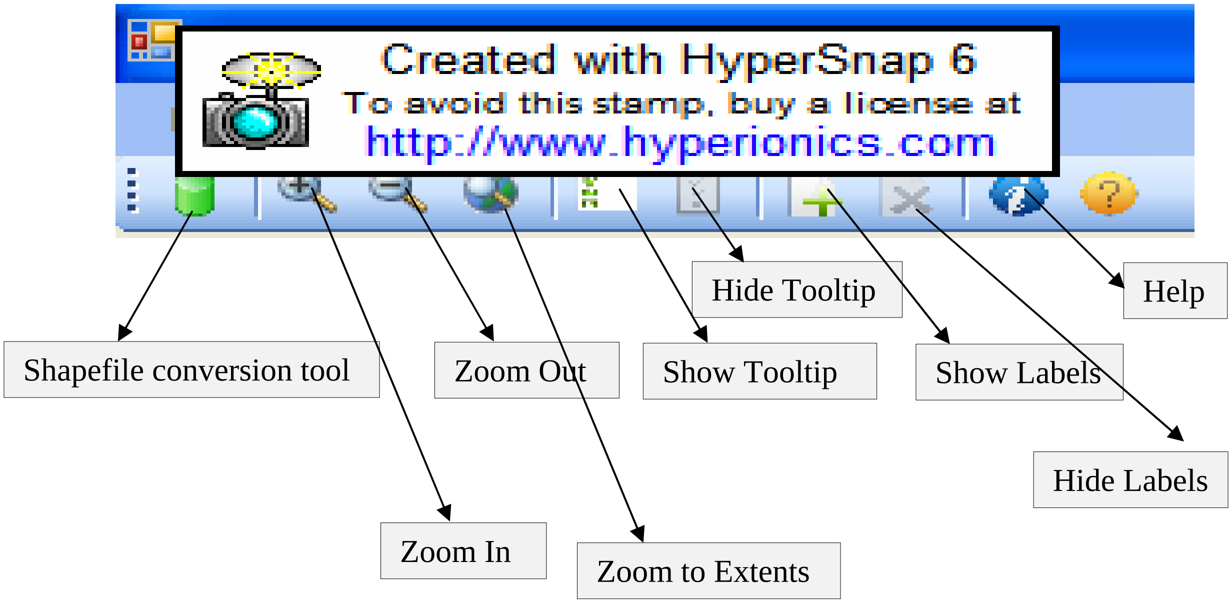
Port corresponds to the port on which the server is configured to run. This typically is 5432 for PostgreSql server. UserId and Pwd correspond to the username and the password used to log into the server. Save the file after the changes have been made and you are ready to start using the application.

Using the Software

This software can be used to either view the Texas Demographic data in the form of interactive maps or to create new maps.

Texas Demographic Data:

The first thing you notice when you open the software is an empty map of Texas. From here you can view different data by using the links on the right. Controls are provided to turn on and off labels and tooltip showing the data for each county. The following figure shows the various tools and their functionality.



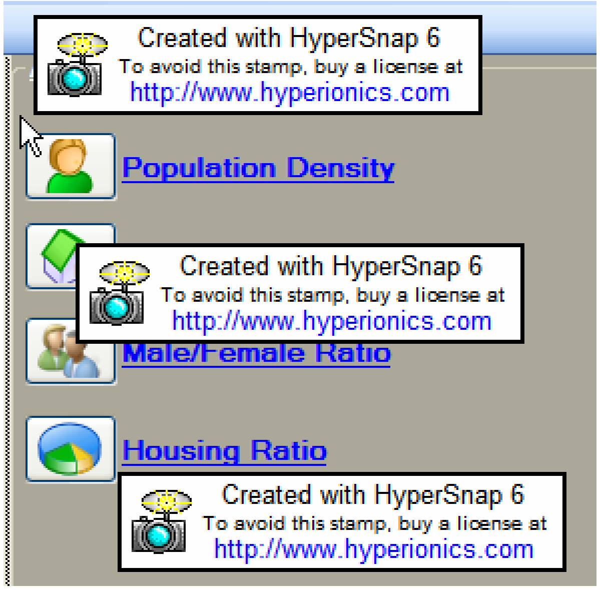
The same tools are also available in the menu control.

Zoom in and Zoom Out: These tools can be used to Zoom In to or out of the map. If the map goes out of focus then the **Zoom to Extents** tool can be used to bring the map to its original size.

Showing and Hiding Tool Tip: Tooltips show data as the mouse is moved over each county. Data for each county is shown on the tooltip. This tooltip is available for all the maps and can be turned off and on by using the Tooltip controls.

Showing and Hiding Labels: Labels show the names of the counties on the map. This might get cluttered when the map is small. Showing and hiding of Labels can be controlled using the Show/Hide Label controls.

Different maps for population density, Housing units etc. can be accessed by clicking on the links to the right.


Created with HyperSnap 6
To avoid this stamp, buy a license at
http://www.hyperionics.com
Population Density
Created with HyperSnap 6
To avoid this stamp, buy a license at
http://www.hyperionics.com
Male/Female Ratio
Housing Ratio
Created with HyperSnap 6
To avoid this stamp, buy a license at
http://www.hyperionics.com

Population Density: Shows a thematic map of Texas with different colors indicating different population densities. A legend is shown on the right side of the map.

Housing Units: Thematic map is shown with the number of housing units in each county. A legend is shown on the right side of the map.

Male/Female Ratio: Map is shown with a pie chart for each county. The pie chart indicates Male to Female ratio for each county.

Housing Ratio: Map is shown with a pie chart for each county. The pie chart shows the ratio of number of housing units occupied by the owner to the number occupied by the renter to the number of vacant units.

Converting Shapefile:

To convert shapefile click on File -> Import Shapefile or Click on the ‘Shapefile Conversion’ tool in the toolbar. You need to have permissions to create tables in the target database. In the resulting window provide your database credentials and open the shapefile to be converted. You can preview the map before loading into the database. Click ‘Upload to Database’ to convert the shapefile to spatial data and upload it into the database. A new table with the same name as the shapefile will be created in the specified database. To view the imported data click on the ‘Preview Data’ button.

The data imported can be used with the software to create new maps or to add the data as a new layer to an existing and relevant map.

Create New Maps:

New maps can be created and layers can be added to the new maps to visualize data in the form of maps. Before a map can be created we need a shapefile with relevant data. The shapefile has to be loaded into the database with the shapefile conversion tool**.** Vector layers can be added to the newly created maps by clicking the ‘Add Layer’ menu item from the ‘Tools’ menu.