

University of Southern Queensland
Faculty of Engineering and Surveying

GIS for House Hunters

A Case Study in Toowoomba

A dissertation submitted by

Tao JIN

**In fulfilment of the requirements of
Courses ENG4111 and ENG4112 Research Project**

Towards the degree of

Graduate Diploma of Geomatic Studies

Submitted: June 2005

ABSTRACT

House hunting is one of the most important activities for many families in Australia and worldwide, which also involves difficult decisions to make. Currently, the process of hunting for a house requires looking and inspecting individual houses with or without the guide of a real estate agent. This is a time consuming process, and even though, the house hunters may still miss out the ideal home they dream of. This project demonstrated a method where Geographic Information System (GIS) technique can be used to help house hunters to identify and choose their dream home.

GIS is a powerful set of tools for capturing, organising, retrieving at will, analysing and presenting spatially referenced data from the real world for a particular set of purposes. This technology is ideal for the application of location-based services, such as the property listing and selling in the real estate industry. In this project, a user-friendly GIS program was developed to manipulate the property listing for sale geographically, to display the property listing in relation to other social and environmental features including topography, transportation, schools and/or shopping centres, and to provide tools for the house hunters to search and inspect properties and make choices without the need of getting into the houses. Even though open house inspection is still required before a final decision is made, these inspections can be limited to only a small number of houses, making the process of house hunting faster and also reducing the danger of missing out the ideal house for the hunter. Compared to the conventional way of getting a property list and inspecting them one by one, the GIS based property searching and inspection tools are proved to be more efficient and less time consuming.

The project demonstrated that GIS provides powerful tools in assisting the house hunters searching for houses and make informed and intelligent decisions. The GIS program developed in this project can be easily used by the real estate practitioners in property selling or renting, which will improve their business efficiency.

University of Southern Queensland
Faculty of Engineering and Surveying

ENG4111 & ENG4112 *Research Project*

Limitations of Use

The Council of the University of Southern Queensland, its Faculty of Engineering and Surveying, and the staff of the University of Southern Queensland, do not accept any responsibility for the truth, accuracy or completeness of material contained within or associated with this dissertation.

Persons using all or any part of this material do so at their own risk, and not at the risk of the Council of the University of Southern Queensland, its Faculty of Engineering and Surveying or the staff of the University of Southern Queensland.

This dissertation reports an educational exercise and has no purpose or validity beyond this exercise. The sole purpose of the course pair entitled "Research Project" is to contribute to the overall education within the student's chosen degree program. This document, the associated hardware, software, drawings, and other material set out in the associated appendices should not be used for any other purpose: if they are so used, it is entirely at the risk of the user.

Prof G Baker
Dean
Faculty of Engineering and Surveying

Certification

I certify that the ideas, designs and experimental work, results, analyses and conclusions set out in this dissertation are entirely my own effort, except where otherwise indicated and acknowledged.

I further certify that the work is original and has not been previously submitted for assessment in any other course or institution, except where specifically stated.

Tao JIN

Student Number: 0050000380

A handwritten signature in black ink, appearing to read 'Tao Jin', written in a cursive style with a long horizontal stroke extending to the right.

Signature

05 June 2005

Date

Acknowledgment

I wish to acknowledge the guidance from my supervisor, Dr Yan Liu at the University of Southern Queensland. Her knowledge and supervision have guided me through to the right direction to complete this project in a timely manner.

I am also thankful for the support and understanding from my family and friends. Without their support, I would not have been able to complete this project.

Table of Contents

	page
Abstract	i
Disclaimer	ii
Certification	iii
Acknowledgement	iv
Table of Contents	v
List of Figures	viii
List of Tables	ix
Nomenclature and Acronyms	x
Chapter 1 Introduction	1
1.1 Background	1
1.2 Project Aims and Objectives	3
1.3 Expected Outcomes	4
1.4 An Overview of the Dissertation	4
Chapter 2 Literature Review	6
2.1 Introduction	6
2.2 GIS and Its Applications	6
2.2.1 What is GIS	6
2.2.2 GIS Applications	8
2.3 Applications of GIS in Real Estate	9
2.3.1 GIS in Property Database Management	11
2.3.2 GIS in Site Selection and Real Estate Transactions	14
2.3.3 Web Based GIS for Real Estate Service	15
2.4 Conclusion	15
Chapter 3 The Study Area and Data	17
3.1 Introduction	17
3.2 The Study Area – Toowoomba	17
3.3 Data Sources	19

3.3.1 Base Data/Maps	19
3.3.2 Property Demand Data	23
3.3.3 Property Supply Data	27
3.3.4 Property Transaction Data	29
3.3.5 Other Miscellaneous Data	32
3.4 Data Processing	35
3.4.1 Data Import and Conversion	35
3.4.2 Data Projection	36
3.4.3 Geo-coding Tabular Data to Spatial Objects	36
3.5 Conclusion	37
Chapter 4 Software Development and Applications	38
4.1 Introduction	38
4.2 Methodology	38
4.3 GIS Software Development	40
4.3.1 Project Planning	40
4.3.2 Needs Analysis	41
4.3.3 GIS Functions Required in the Real Estate Information System	45
4.3.3.1 Spatial Query	45
4.3.3.2 Attribute Query	45
4.3.3.3 Database Update	45
4.3.3.4 Geo-coding	46
4.3.3.5 Hotlink to Photos, Images and Video Clips	46
4.3.3.6 Output Display	47
4.3.4 GIS Interface Design	47
4.3.4.1 Three Steps in GUI Design	47
4.3.4.2 GUI Design using Avenue	48
4.3.4.3 GUI for Toowoomba Real Estate Information System	49
4.4 Software Applications	56
4.4.1 Updating the Property Listing Database	56
4.4.2 Geo-coding the Property Data	58
4.4.3 Searching/Querying the Database	59

4.4.3.1 Attribute based search/query	59
4.4.3.2 Spatial based search/query	62
4.4.4 Presenting Results	63
4.5 Conclusion	64
Chapter 5 Conclusions and Further Development	66
5.1 Introduction	66
5.2 Summary of Achievements	66
5.3 Further Development	67
List of References	69
Appendices	73
Appendix A Project Specification	73
Appendix B Software Program on CD (can only be run on computers where ArcView 3 is installed)	

List of Figures

	page
Figure 2.1 An Example of the Information on a SmartMap	13
Figure 3.1 Toowoomba and its Location in Queensland	18
Figure 3.2 Toowoomba Street Directory in Digital Format	20
Figure 3.3 Digital Cadastral Database of Toowoomba Region	22
Figure 3.4 Toowoomba Schools and Churches	23
Figure 3.5 Other Datasets Collected as Base Information	24
Figure 3.6 Population Densities in Toowoomba (2000)	26
Figure 3.7 Sample Collections of Property Supply Data in Toowoomba	28
Figure 3.8 A Sample of the Property Transaction Data from the Home Price Guide™	30
Figure 3.9 Property Sale Transactions in Toowoomba (April 2003 – March 2004)	31
Figure 3.10 Urban Zoning in Toowoomba	33
Figure 3.11 An Ortho Photo of Toowoomba in 2000	34
Figure 4.1 The GUI for the Real Estate Information System	49
Figure 4.2 Updating the Property Listing Database	57
Figure 4.3 The Query Builder Window	59
Figure 4.4 Searching the Database	60
Figure 4.5 A display of the Selected Properties	60
Figure 4.6 A Zoom-in Look of the Selected Property	61
Figure 4.7 Building a Multiple Criteria Query	62
Figure 4.8 A Similar Function Available in ArcGIS 8	63
Figure 4.9 A Sample of Layout to Present Selected Properties Results	64

List of Tables

		Page
Table 4.1	Sample Avenue Script (1)	59
Table 4.2	Sample Avenue Script (2)	52
Table 4.3	Sample Avenue Script (3)	55
Table 4.4	Avenue Script for Property Listing Update	57

Nomenclature and Acronyms

The following abbreviations and acronyms have been used throughout this document:

ESRI: The Environmental and Scientific Research Institute

GIS: Geographic Information System

USQ: The University of Southern Queensland

Chapter 1 Introduction

1.1 Background

House hunting is one of the major and most important activities for many families in Australia and worldwide. According to the Australian Bureau of Statistics (ABS), the total construction or purchased new and existing dwelling units for owner occupation in 2003-04 were 647,449, which was over 10 per cent of the total number of families in Australia (Australian Bureau of Statistics 2005), and the total financial value of commitments was \$123,763 millions. In addition, the finance commitments for investment housing in 2003-04 were \$75,873 millions. Therefore, looking for and choosing the right dwelling unit for either self occupancy or investment becomes very important for the lifestyle of many families.

Traditionally, when people want to buy a house, they need to seek for assistance from a real estate agency. They will normally be given a list of properties available on the marketplace and have a drive-by of each property and see if any of them looks appealing from outside. They will then need to organise with the real estate agent a time for an open house inspection. This is a very time consuming process. Even so, the buyers may still run into the danger of missing out the ideal house they want.

With the increased use of computerised information in every part of our everyday life, more and more people are using geographical, social, economic, political and environmental information electronically to answer practical questions in their lives. To explore their growing part of everyday life, people are using a range of electronic tools designed for acquiring, presenting and interacting with information. One of these tools is the Geographical Information System (GIS).

GIS is a tool that uses the power of computers to pose and answer geographic questions by arranging and displaying data about places on the Earth in a variety of ways, including maps, charts and tables (Al-Husaini 1997). GIS is also a collection of spatially referenced data (i.e. data that have locations attached to them) and the tools required to work with the data. This technology can be used by anyone who needs to work with spatially referenced data – to manipulate the data, retrieve data at will, analyse and present the data for a particular set of purposes.

The application of geographical information system in the real estate industry is not new. GIS allows people to integrate a wide variety of data into one common format, a map. The presentation of a wide variety of data on one or two maps gives a far more accurate picture of the property's suitability as the ideal home for live or investment (ESRI 2004). This will help the house-hunters to look and compare different properties and make their decisions more easily. Many times the lack of a nearby school or proximity to a busy road/highway will disqualify the property before it can be shown. Conversely, proximity to a park, greenbelt, or entertainment facilities may practically pre-sell a property. Many realtors have discovered the value of showing available residential property on a map prior to actually showing the client the property (ESRI 2004).

Despite the obvious advantages of using GIS in the real estate industry, as GIS is all about locations, the application of GIS in the real estate industry is still not popular. This is partly because of the lack of good base datasets in digital format, and partly because of the lack of GIS knowledge by the real estate practitioners (Liu 2004). Unless people are confident of what GIS can do for their business, they tend to use the traditional way of showing the buyers around the properties. Nevertheless, there are increasing interests in the use of GIS for the property hunting as well as real estate market analysis.

In this project, a GIS program will be developed to manipulate the listings of property sell data, to integrate the property listing data with other social and environmental datasets and to search for and display property sale listing with

the various functionalities provided by the GIS program. It is expected that the GIS program developed in this project can be used by the real estate practitioners to assist the house hunters to identify and select their ideal house.

1.2 Project aims and objectives

The aim of this project is to demonstrate how GIS can be used to help house hunters to identify their dream houses using Toowoomba as a case study area.

Specific objectives of the project are as follows:

- to review literatures in the area of GIS applications in business, especially in the real estate industry;
- to collect and manipulate data required for developing a real estate information system using GIS technology;
- to develop a property hunting GIS software program for the study area;
- to test the GIS program developed by conducting case study scenarios in house hunting;
- to identify the strengths and limitations of the program in the application of house hunting practice; and
- to further explore the application scope of the GIS program in the real estate industry as well as the future research and development directions.

1.3 Expected outcomes

The expected outcomes of this project are:

- a user-friendly GIS software program for real estate property listing search and display;
- the display of property sale dataset and its relationship with other social and environmental datasets;
- various application scenarios in the application of the program in property hunting practice;
- an analysis of the strength and limitations of the GIS program developed in this project; and
- a dissertation addressing the development and application of the GIS program developed in this project.

1.4 An overview of the dissertation

There are five chapters in this dissertation. Following this first introductory chapter, the second chapter provides a comprehensive review on GIS technology and its application in location based services, and in particular the application of this technology in the real estate industry. This is followed by Chapter Three, which discusses the study area in Toowoomba and the various datasets that were used in this project. Chapter Four discusses in detail the methodology used in the development of the GIS program and the process of developing this program. It also presents various scenarios of testing the software program. The whole project is concluded in Chapter Five, which summarizes the achievements of the project and also discusses the strengths and limitations of the current version of the project. Future research

and development directions on the program developed in this project are also addressed in the last chapter of this dissertation.

Chapter 2 Literature Review

2.1 Introduction

This chapter provides a review on literatures in relation to GIS technology and its applications in location-based services. In particular, it will review literatures on the application of GIS technology in the real estate industry.

2.2 GIS and its applications

Society is now so dependent on computers and computerised information, which has opened a vast new potential in the way that people communicate, analyse our surroundings and make decisions (Bernhardsen 2002). Many of our decisions depend on the details of our immediate surroundings and require information about specific places on the Earth's surface. This information is called geographical or spatial information and it allows us to apply general principles to the specific conditions of each location. It also helps us to track what is happening at any place, and to understand how one place differs from another (Bernhardsen 2002). With the development of GIS technology, data representing the real world can be stored and processed in computers so that they can be represented in simplified forms to suit specific needs.

2.2.1 What is GIS?

Geographical Information System, or GIS in short, is a set of computer based tools for capturing, organising, retrieving at will, analysing and presenting spatially referenced data from the real world for a particular set of purposes (Burrough 1986). This technology can be used by anyone as we all use and make decisions based on spatial data all the time. For example, the locations of your dwelling, work place, schools, nearby stores, banks, and local

landmarks are all included in your personal spatial database and are normally what you would think of when asked about spatial data. These data or information are normally stored on maps or in a spatial information system, that is, in a geographical information system.

In GIS, data are stored as layers. In order to better organise geographical data in a region, data that describe similar themes are stored as separate layers. For example, in a standard topographic map, you can see contours, road networks, stream networks, power lines, forested areas, buildings, and spot heights, etc. Each of these features will be stored as a separate layer in a GIS, which allows easy overlay analysis and display of the data at your will.

GIS is not only capable for storing spatial related data, it also provides a lot of tools or functions for people to use. Amongst them, spatial and attributed based query of the database, overlay analysis and network analysis are the most common ones. For example, you may need to find out where is the nearest grocery store, how do I get there, etc. When we move to a new part of a town (or even a new town), our queries often come up blank and we have to update our neighbourhood databases with the locations of stores, bus stops, parks, and so on.

With GIS, people can also undertake various network based analysis, be it simple path finding or more complex route planning. For example, you may need to plan an optimal route from your home to some other places. You may want to make it the shortest route, or the quickest route with less traffic congestions. This can be made more complex by your significant other callings such as visiting a friend or a park, stopping by a grocery store on the way home and picking up some broccoli for dinner. If the park or the store is significantly out of your way, you may have to adjust the route for your trip home. To efficiently plan your route, an up-to-date information systems including street directories, road traffic conditions, location information about stores, shops and parks, etc. are essential base data to achieve your goal.

2.2.2 GIS applications

GIS has many applications in the spatial information industry. By reading a variety of literatures on GIS and related field, a summary of GIS applications can be listed as follows:

- Mapping
 - Mapping is the primary purpose and direct output of all GIS applications
- Land Surveying
 - Zoning, subdivision plan review
 - Land acquisition
 - Environmental impact statements
 - Water quality management
 - Maintenance of ownership
- Facilities/Assets Management
 - Locating underground pipes, cables, etc.
 - Balancing loads in electrical networks
 - Planning facility maintenance
 - Tracking energy use
- Location Based Services
 - Address matching - finding locations by given street addresses
 - Vehicle routing and scheduling
 - Location analysis and site selection
 - Development of evacuation plans
- Natural Resources/Environmental Mapping & Management
 - Management of wild and recreation resources, wetlands, agricultural lands, forests, wildlife, etc.
 - Environmental impact analysis
 - Hazardous facility siting
 - Groundwater modelling and contamination tracking
 - Wildlife habitat analysis, migration routes planning
- Marketing and Tourist Mapping
 - Track customer locations

- Search for business site
- Target marketing campaigns
- Optimize sales territories
- Model retail spending patterns
- Service Infrastructure
 - Electric / gas utilities - track maintenance, monitor regulatory compliance, model distribution analysis, transformer analysis, load analysis, etc.
 - Transportation - monitoring rail systems and road conditions or finding the best way to deliver your goods or services
 - Water / wastewater networks planning, engineering, operations, maintenance, finance, and administration
 - Telecommunications, mining, pipeline, healthcare ...
- Emergency Services/Risk Management
 - e.g. fire and police

From the long list above, we can say that GIS can be applied to wherever spatial data analysis is needed!

2.3 Application of GIS in real estate

Both geography and real estate value the importance of location. After all, it is the real estate practitioners who coined the phrase "location, location, location" (Thrall 1998). Therefore, before reviewing the applications of GIS in real estate, the meaning of location in the context of real estate will be discussed. As Thrall (2002) explained, "all real estate has a location. Geographers measure location either absolutely or relatively. Absolute spatial location requires a pair of geographical coordinates, such as longitude or latitude. Relative spatial location requires a single distance measurement such as distance from a city centre or distance from the seashore."

Of primary concern to the real estate practitioners are the relative spatial locations, that is, a location or distance from a known spatial object. For example, how far away is the property to a local school or shopping centre? Is it close to the beach? Is there any child care facility available within a certain distance? Is the area subject to flooding? Real estate practitioners need to manage, display and analyse the information about the spatial location of the properties they manage to sale or rent out the properties. Many times the lack of a nearby school or proximity to a busy road/highway will disqualify the property before it can be shown. Conversely, proximity to a park, greenbelt, or entertainment facilities may practically pre-sell a property (ESRI 2004). Although many real estate practitioners are still using conventional tables or spreadsheets to store and manage their information, the spatial or location characteristics of this information cannot be presented efficiently. Conversely, many real estate practitioners have discovered the value of showing available residential property on a map prior to actually showing the client the property. Presentation of listings on a map is also an excellent way to gracefully introduce the subject of disclosure into the transaction (ESRI 2004).

As a set of computer based tools used to collect, store, manipulate, analyse and display geographical information, GIS offers a unique solution to manage real estate information efficiently as it has the capability to integrate different types of data originating from different sources and present them in visual form, that is, through maps and multimedia services. Using a geographical information system (GIS), one can easily view and analyse sophisticated demographic information and prepare a reasoned analysis in an easy-to-read, graphically interesting format. The data manipulation functions of GIS, including spatial and attribute query, buffering and overlay analysis provide users with the flexibility to search and query their database. The various data visualisation and spatial analysis and modelling capabilities of GIS also allow users to visualise their data spatially, and to allow for the generation of different scenarios to assist spatial viewing and decision-making.

GIS has many applications in the real estate industry. In fact, if anyone types in “GIS and Real Estate” in any of the Internet search engine such as Yahoo,

one will find more than 120,000 literatures available in this category! If one searches the Australia sites only, there are still around 1970 literatures available on the Internet.

One of these literatures is a publication entitled “GIS in Real Estate” edited by Castle and published by the Appraisal Institute in 1998. Apart from the discussions on the setting up of a GIS in real estate industry, it also provides case studies to show readers how their peers and competitors are making decisions — and money — by performing in-depth, sophisticated analyses from their desktop computers using GIS technology (Castle 1998).

Another literature by Landis (1998) summarised the use of GIS in real estate as the following aspects; appraisal; brokerage; database management; market research and retailing. Other applications of GIS in real estate include property management, appraisal litigation and insurance underwriting (Mao Chiu Dik 2003). The following reviews some of the important applications of GIS in real estate industry that are of relevance to the current project.

2.3.1 GIS in property database management

A comprehensive database is the soul of a real estate information system (Mao Chiu Dik 2003). Such a database should include the demand data, supply data, transaction information, base data/maps and other miscellaneous data (Landis 1998).

Demand data, which normally refer to the demographic distribution of the population within the area, such as population and household statistics, shows the locations and the potential number of real estate users. Supply data shows the location and amount of any particular types of properties or land. Transaction data provide information on prices of the properties or land. Base data or maps display the basic geographical features of the area such as topography, street directories and buildings, and can be used to locate other relevant information such as schools, shopping centres, etc. Finally, the

miscellaneous data include regulatory data such as zoning plans, photos and aerial photograph and satellite imageries.

All these five types of data need to be managed in a comprehensive geographic database. Without a complete, up-to-date and accurate property geo-database, including both the attribute description about the properties and the spatial location data associated with the attribute data, all dealings with property site selection and transaction will be inefficient and eventually lead to a “garbage in, garbage out” situation.

GIS has been used as a database management tools in property management by various government organisations and agencies (Dale and McLaren 1999; Landis 1998; Wyatt 1996; Hyde 1991; Yeh 1991). For example, in Queensland, the Department of Natural Resources and Mines uses GIS to manage their all of their property dealings. The Digital Cadastre Database (DCDB) provides base maps for all properties in Queensland. This information, together with other base data and imageries are managed in their SmartMap (formerly BLINMAPs), which is the primary point of property information enquiry. SmartMap displays current information including Queensland property boundaries, Queensland valuations and sales data and Queensland survey information. Amongst the four types of SmartMaps, that is, the Queensland property sales map, Queensland cadastral map, Queensland valuations map, and Queensland surveying map, the Queensland property sales map is of particular interest to the home buyers or sellers as it provides information about recent property sales, property boundaries, street location and titles information to the client (Figure 2.1).

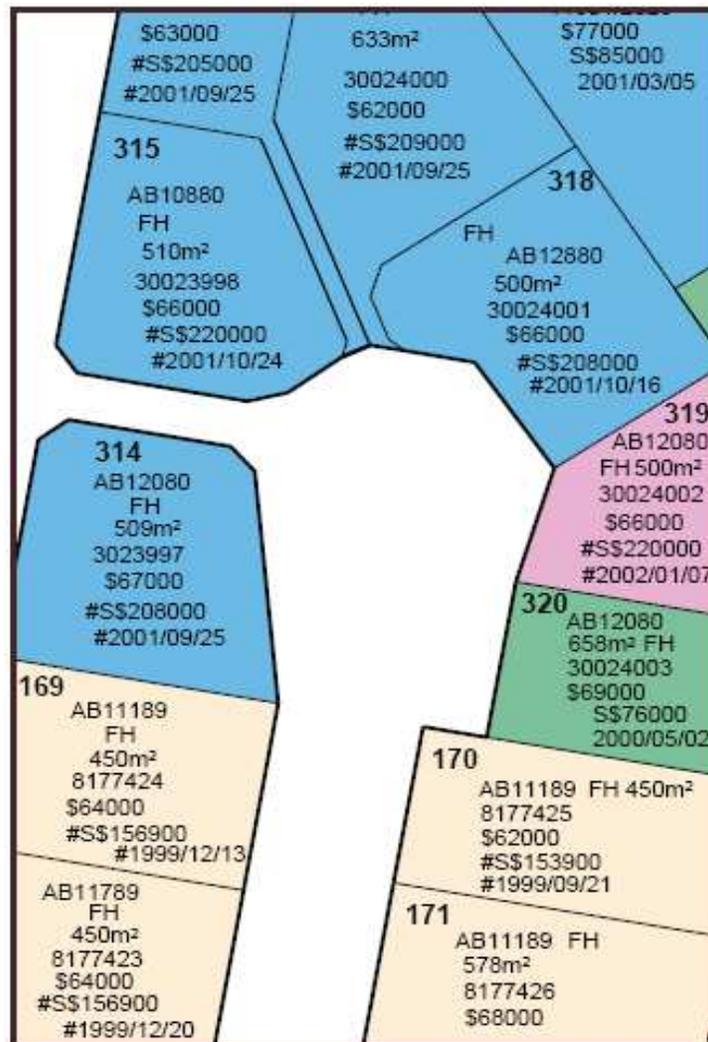


Figure 2.1 An Example of the Information on a SmartMap

(Source: <http://www.nrm.qld.gov.au/factsheets/pdf/land/L99.pdf>)

The contents and structure of the property database are created to satisfy the requirements of each organisational requirement and the needs of their clients. For the Department of Natural Resources and Mines in Queensland, the SmartMap property management system is managed in-house, and it is currently not available to the public over the Internet, however, this service may be available to the public using the Internet service in the near future.

2.3.2 GIS in site selection and real estate transactions

Site selection has been the most prominent and traditional area for GIS in real estate. Various GIS models were developed to identify “winning” sites and then real estate representatives are sent out to determine whether the properties can be acquired (Daniel 1994). GIS tools have been used to invert the whole process of site selection, shifting the emphasis away from simply “making deals” and placing increased emphasis on understanding the potential performance of these locations. This process has helped buyers to reduce the risk of making a wrong decision and increased the likelihood of success (Daniel 1994).

Various research and applications can be identified in site selection or land suitability analysis for real estate or land use planning (Inglis 2002; Quiambao 2001; Barnett and Okoruwa 1993). Although different approaches have been used for different applications, the criteria selected for site identification are in line with the objectives of application or problem to be solved (Mao Chiu Dik 2003).

Amongst other GIS functions, the commonly used GIS functions in real estate site selections include spatial and attribute query, overlay and buffering analysis. Spatial and attribute query are commonly used to answer questions in GIS. For instance, how many properties are listed for a price between \$200,000 to \$400,000 and where are they? Where is the nearest school to the property? How far away is the property to the nearest shopping centre? List all properties that are 5 kilometres away from the highway and are not subject to flooding. Spatial and attribute queries are normally applied in conjunction with the overlaying and buffering functions. Quiambao (2001) used a set of criteria to identify recreation sites by overlaying and spatial and attribute querying. The selected sites were further evaluated by buffering with various geographical features such as road and forest. In the real estate area, Barnett and Okoruwa (1993) used the overlay and buffer functions of GIS to identify the optimum location for the development of a rural suburban residential

community. Ling and Smersh (1996) also used GIS functions to select optimal site locations for retail establishments.

Another functional application of GIS is in real estate transaction. Al-Husaini (1997) developed an information system called Al-Masfaq Real Estate Trading Information System (Mretis) to support real estate trading transaction for the city of Riyadh. It was also designed to accommodate other cities as well. This system was designed to manipulate real estate spatial properties and classification information; to register real estate entities for trading; to search for and display tradable real estate entities; to display data and to produce and display sketches, reports, log files and images associated to the properties in the database (Al-Husaini 1997).

2.3.3 Web based GIS for real estate service

More recently, with the development and widespread use of the Internet and the World Wide Web (WWW), research has been carried out to integrate GIS technology, management information systems (MIS) and the network technology (GMN) and apply them to the real estate industry in the Internet environment (Lin, Meng and Pan 2001). GMN system was applied to help real estate marketing and sales using the World Wide Web. Users can use the Internet to access the real estate information system and conduct activities such as spatial querying, selection and displaying of the data they selected. In this aspect, in-house GIS software program of real estate management has been developed; other commercial GIS software programs such as ArcIMS developed by ESRI are also available to provide web based GIS solutions (ESRI 2004), although the commercial GIS software programs are normally more expensive for the real estate practitioners or agents to purchase.

2.4 Conclusion

This chapter provided a general review of literatures on GIS and its various application areas. In particular, the applications of GIS in the real estate

industry have been reviewed systematically. With the various capabilities of GIS in data manipulation, query, analysis and modelling, as well as its powers in presenting geographical data through maps and other visual presentation, GIS provides an efficient tool for spatial or location based services and analysis. In the real estate industry, GIS has commonly been used in property database management, site selection and real estate transaction, and in Web based property services.

Even though a significant amount of literatures have been found in the field of GIS in real estate applications, many of these literatures are for research purpose only, or for database management by various government organisations. Practical GIS application programs that can be used by the real estate practitioners and the house hunters to manage, search for and identify real estate properties or land that meet their specific requirements are still not available. The proposed research project is therefore aimed to develop such a program to be used in the real estate industry, to supplement the gap in the subject area.

Chapter 3 The Study Area and Data

3.1 Introduction

In this chapter, an introduction about the study area, its geographical, social, economic and environmental conditions are presented first, followed by discussions on the identification of real estate data and various other base data and maps, and the GIS techniques used for the processing of the various data sources. The data sources identified and processed in this chapter will be used in the GIS software program for real estate, which will be discussed in Chapter Four.

3.2 The study area – Toowoomba

In this project, Toowoomba was selected as a case study area (Figure 3.1). Toowoomba is Australia's largest inland regional city. It is about 118 square kilometres in size and is located 700 metres above sea level on the Great Dividing Range; about 90 minutes drive from the Queensland capital, Brisbane, Australia. Considered as Queensland's 'Garden City', with more than 150 public parks and gardens, Toowoomba is renowned for its architecture and open spaces that overlook the Lockyer Valley. In 2002, there were 91,187 residents living in Toowoomba. This population has been growing at an average annual rate of 0.7% over the last ten years (Toowoomba City Council 2003). It is the economic and commercial hub of the Darling Downs Region in Queensland and services a diversity of primary and secondary industries. The city plays a significant role in the economic development of a large region of southern and southwestern Queensland in Australia.



Figure 3.1 Toowoomba and its Location in Queensland

The largest type of businesses in Toowoomba is Property and Business Services, which accounted for 20 per cent of the businesses in Toowoomba in

2001 (Toowoomba City Council 2003). Among them, housing sales play a significant role. For instance, during the twelve months period of March 2003 to February 2004, there were a total of 3635 property sale records in Toowoomba. Among them, 2368 were detached houses, selling at an average price of A\$197 867. This represents a significant increase from A\$144,010 in 2002 and A\$125,266 in 2001. The median price of \$176,000 in the 2003-2004 periods is also higher than in 2002 (A\$125,000) and 2001 (A\$110,000), which reflects both rising house prices and increasing activities at the upper end of the market.

3.3 Data sources

There are five different types of datasets in a comprehensive real estate information system. They are the demand data, supply data, transaction information, base data/maps and other miscellaneous data (Landis 1998). This section will discuss the five types of databases identified and collected from various sources in the Toowoomba region.

3.3.1 Base data/maps

Base data or maps include topographic maps, street directories and buildings location maps. These data/maps display the basic geographical features of the area and they are used to locate other relevant information such as schools, shopping centres, etc.

In this project, the Toowoomba street directory database was provided by USQ staff for the purpose of this project, and the database was originated from the Toowoomba City Council. A snap shot of this directory map is displayed in Figure 3.2.

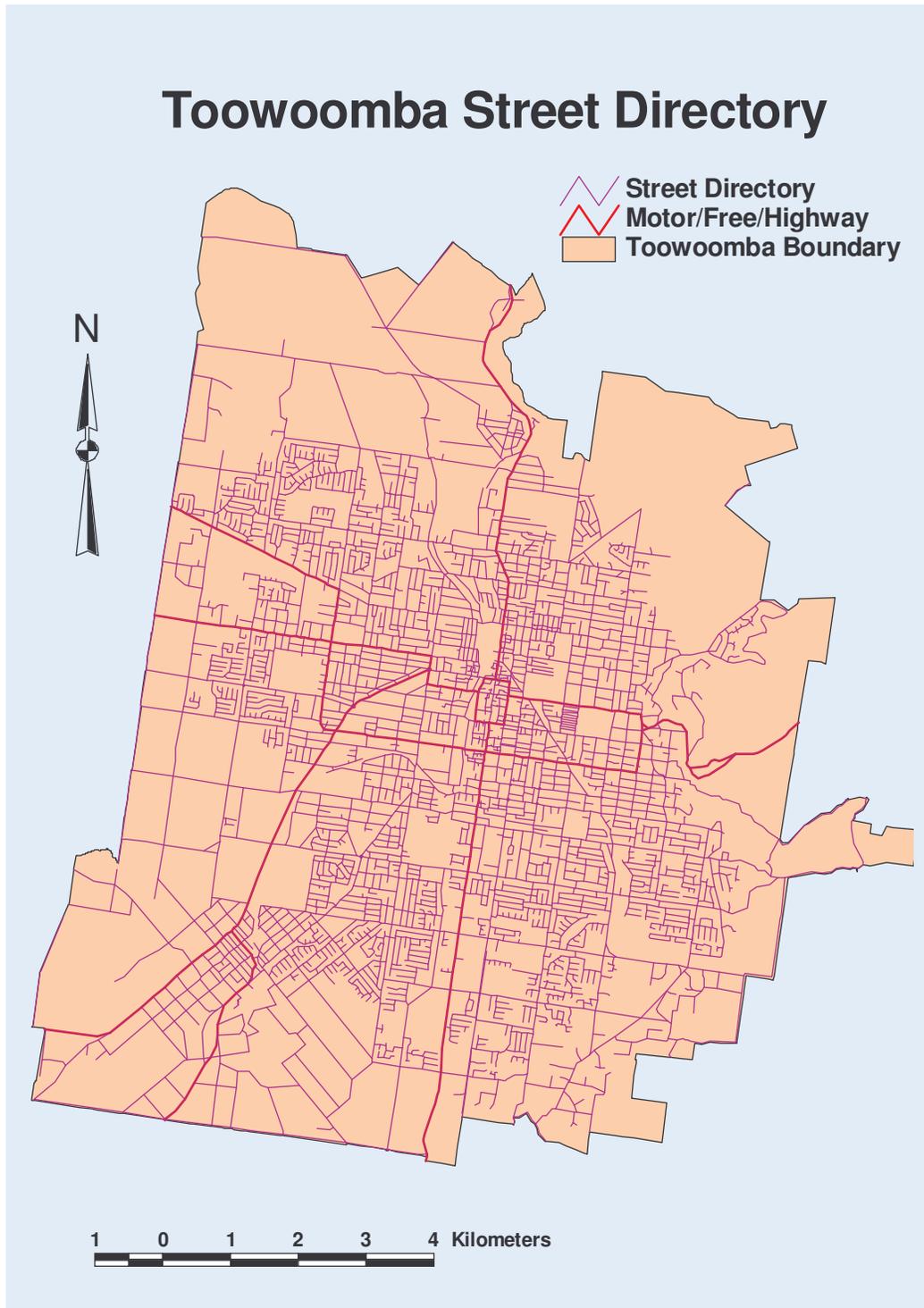


Figure 3.2 Toowoomba Street Directory in Digital Format
(Source: Toowoomba City Council 2004)

In addition to the street directory map, other base data, including the digital cadastral database (DCDB), locations of schools, churches, and shopping centres are also collected or extracted from other sources. DCDB is a spatial representation of property boundaries and the related property description of land parcels. It can be considered to be a computerised map of all land parcels in Queensland (DNRM, available at <http://dnr.qld.gov.au/property/mapping/dcdb/index.html>). The DCDB is maintained by the Bureau of Land Information and Titles within the Department of Natural Resources and Mines in Queensland. Digital cadastral data is used by a variety of organisations as an asset management tool and is an ideal base for searching, planning and analysis of land related information.

The DCDB was built by manually digitising the best available maps and therefore is only as accurate as the maps on which it is based. The accuracy is being improved on a project basis by using survey control data and survey plan information. It is continuously updated by the input of information from registered plans of subdivisions as well as other information from government gazettes and administrative notifications.

DCDB provides data about the property boundaries, as well as the lot number and the plan number of each of the properties. This information proved to be very useful as identifiers to match with the property supply datasets in this project (Figure 3.3).

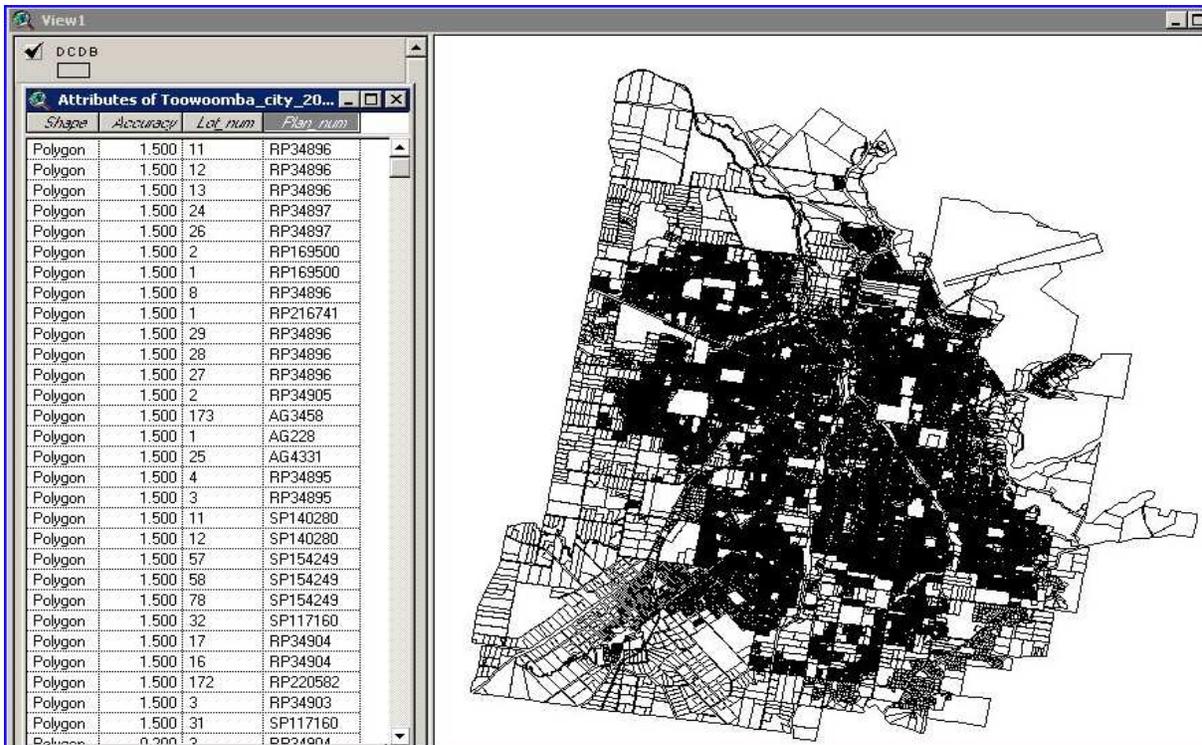


Figure 3.3 Digital Cadastral Database of Toowoomba Region

(Source: Department of Natural Resources & Mines 2004)

DCDB has been made available to the public in 2004, with only a small cost of \$99 to cover the whole of Queensland. USQ has purchased this product from DNR&M in a previous project student and is therefore provided by the staff for the current project.

Data illustrating the locations of schools, churches, parks and shopping centres are all extracted from the DCDB using GIS's spatial and attribute query functions and other tools, which will be discussed in detail in the following section. A screen snapshot of the datasets illustrating the locations of schools and churches is demonstrated in Figure 3.4.

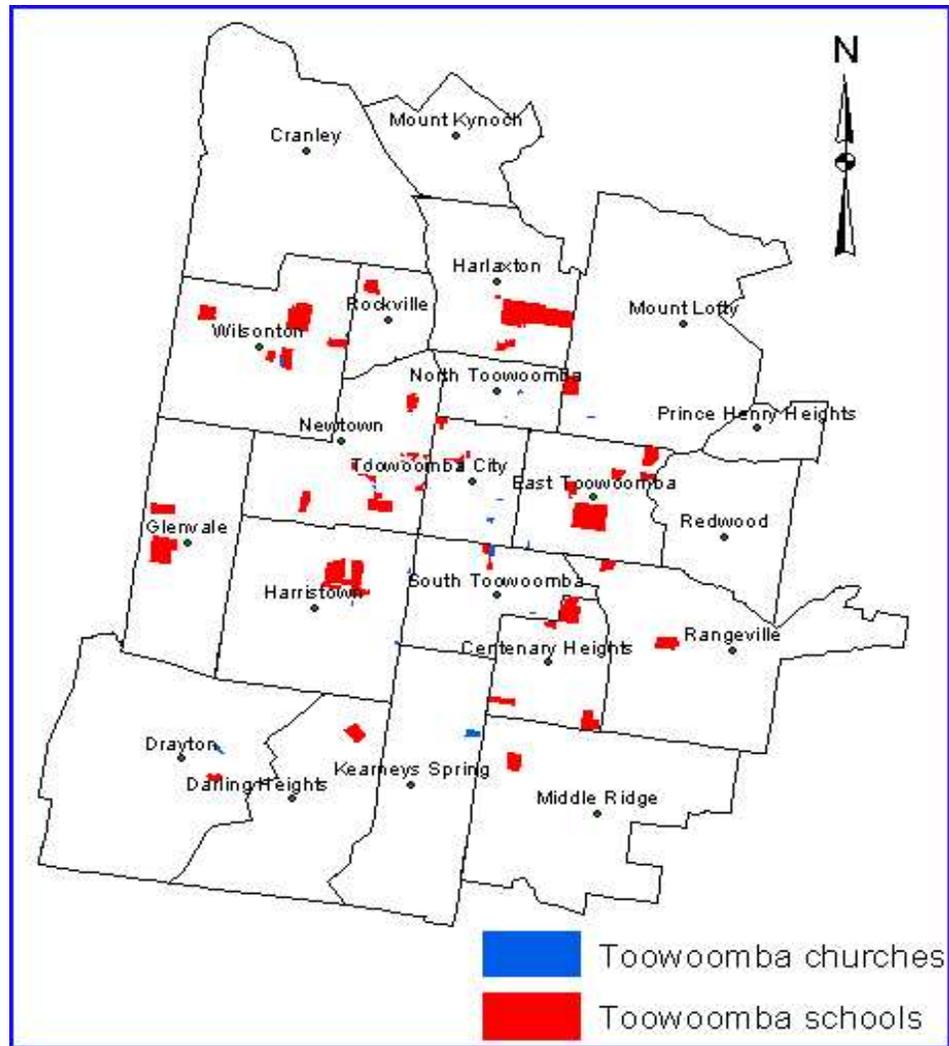


Figure 3.4 Toowoomba Schools and Churches

(Source: Toowoomba Property Map from Toowoomba City Council 2004)

In addition, other information, such as stream lines, bus routes, railways and railway stations, airfield, motorways/freeways/highways etc are also quite useful to be stored in the real estate information system and used by the house hunters when they consider buying any particular house. For Toowoomba region, these data were also collected from various sources (Figure 3.5).

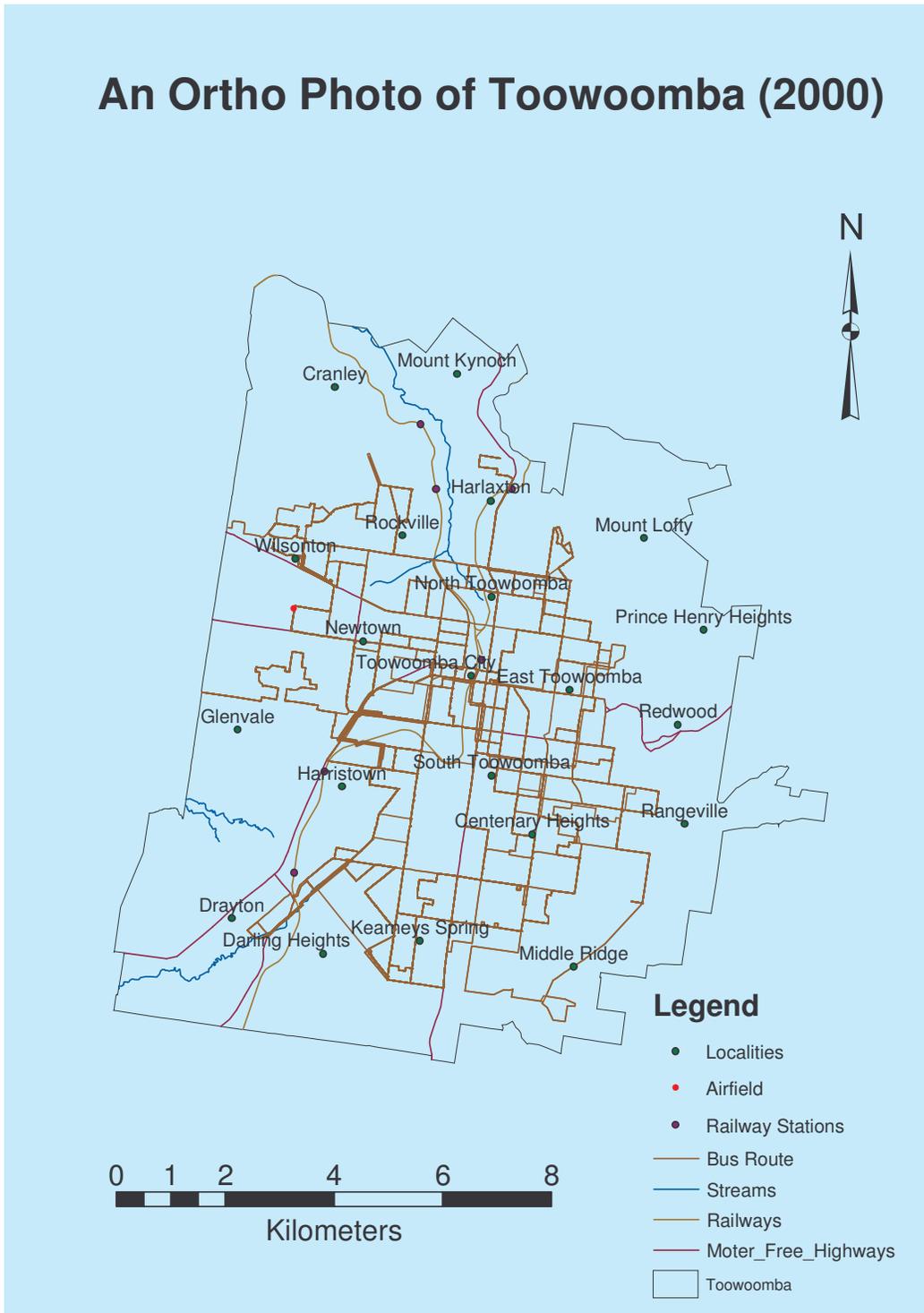


Figure 3.5 Other Datasets Collected as Base Information

3.3.2 Property demand data

The demand data of a real estate database demonstrates the number of potential real estate users and their locations. This data normally refer to the demographic distribution of the population within the area, such as population and household statistics. In this project, the latest data on population and household statistics are from the census data published in 2000, that is, the CDATA 2000 (ABS Australian Bureau of Statistics 2000) (Figure 3.6).

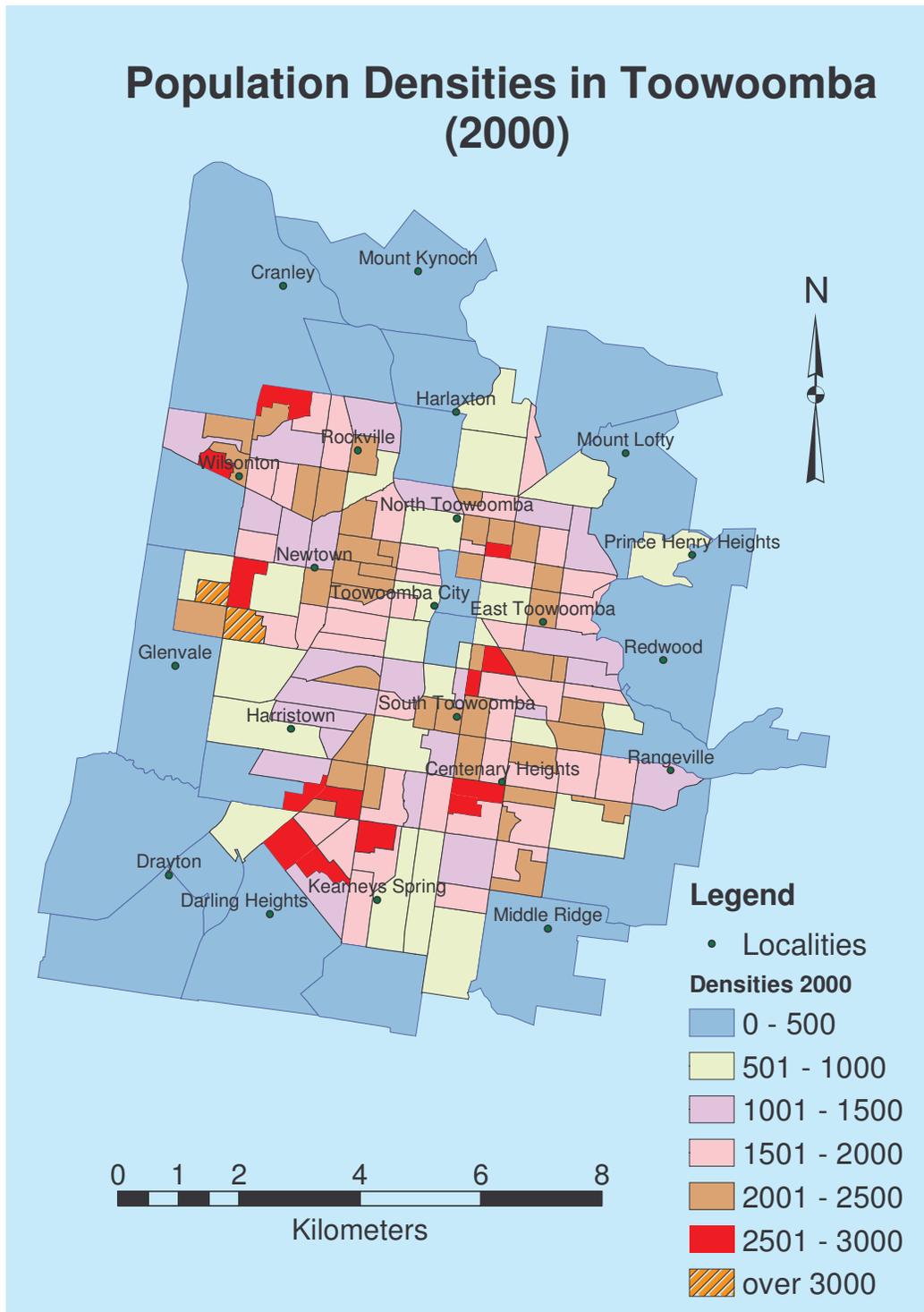


Figure 3.6 Population Densities in Toowoomba (2000)
 (Source: CDATE 2000 Australian Bureau of Statistics)

From this census data, it is obvious that most of the outskirts suburbs have a population density of less than 500 persons per square kilometres. The inner

part of the city has a higher population density of more than 500 persons per square kilometres, with the exception that the central business district (CBD) has low residential population density as the outskirt suburbs. A few of the Census Collection Districts (CDD) have a higher density of 3000 persons per square kilometres or over. Although more up-to-date data about population and household statistics are not available in this project, research shows that there is a positive correlation between population density and the property sold prices (Liu 2004), which demonstrates a higher demand of properties in high population density areas.

3.3.3 Property supply data

The supply data of real estate properties or land is the most critical dataset in a real estate database. This information shows amount of any particular types of properties or land that is available in the marketplace and their geographical locations. However, the collection of this information is not easy. The main reasons for this are twofold: one is that each of the real estate agents maintains their own list of properties on sale, which is not shared in most cases. Another aspect is that the property supply data is in a constant change motion, with a lot of the existing listings off the market, while a lot of other new listing coming to be available in the marketplace all the time. Therefore, collecting, updating and maintaining an accurate, complete and up-to-date database for the property supply data becomes an almost impossible task.

As the primary objective of this project is not in the management of a real estate database, but in the development of a software program to manipulate the real estate databases and provide tools to the house hunters in their searching for houses, only a sample collection of the property supply data for a specific period of time were collected and used in this project. This sample data were collected by visiting a number of real estate agents in the Toowoomba region and by searching on the Internet. With the availability of either the property addresses or the lot or plan numbers, the sample property supply data were then geo-coded to the property boundary database for

further processing and usage. The geographical locations of the sample property supply data is illustrated in Figure 3.7.

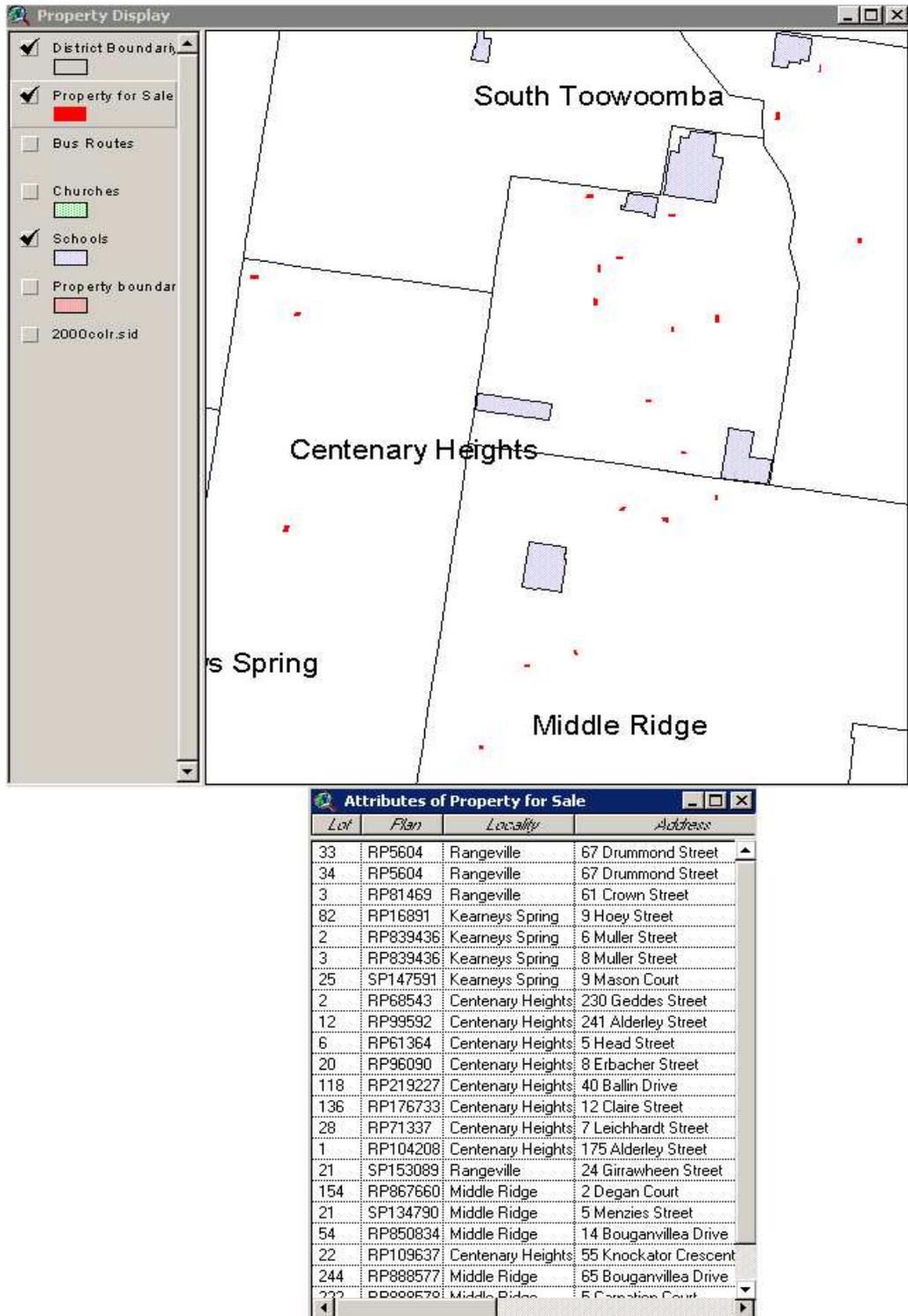


Figure 3.7 Sample Collections of Property Supply Data in Toowoomba

3.3.4 Property transaction data

Past records of property transactions provide information on the locations and prices of the properties or land. This information is considered important and useful for the home buyers to consider and compare when they are considering of buying a property. The property transaction information can be obtained in two different ways. It can be collected from the Department of Natural Resources and Mines as this information is contained in their SmartMap Information System (DNR&M 2004). Alternatively, the real estate transaction records can be collected from the Home Price Guide™, a web-based data service managed by the realestate.com.au. This is an Australian company that provides Internet and technology services to the real estate industry, online property listings and related services. Home Price Guide™ provides the most up-to-the-minute and detailed property sale information online for Australia's homebuyers, sellers, owners, investors and real estate professionals. The Home Price Guides™ includes data obtained from a variety of sources - real estate agents, state governments, real estate advertisements (print and electronic) and its own auction reporters. It is regarded as the leading source of reports for property prices (house prices and unit prices) and auction results in Australia (Liu 2004).

The Home Price Guide™ is generated and provided to the user based on postcode boundaries. It includes information like the street address of the property, type of the property (whether it is a house, a unit, or a land, etc), size of the land, the selling agent, date the property was sold, the event type (whether it is private sold, or tender sold, or auction sold, etc.) and the price sold. In this project, a twelve months data from the Home Price Guide™ was provided by the supervisor to conduct this project. The data provide property transaction information in Toowoomba region from 1 April 2003 to 31 March 2004. The property transaction records data was originally in HTML format when it was provided by The Home Price Guide™ (Figure 3.8), however, work has been done by the supervisor to convert the original data into a dbase file and then geocoded into the property boundary database based on the street

address provided in the original dataset. A sample of the geocoded property transaction data is displayed in Figure 3.9.

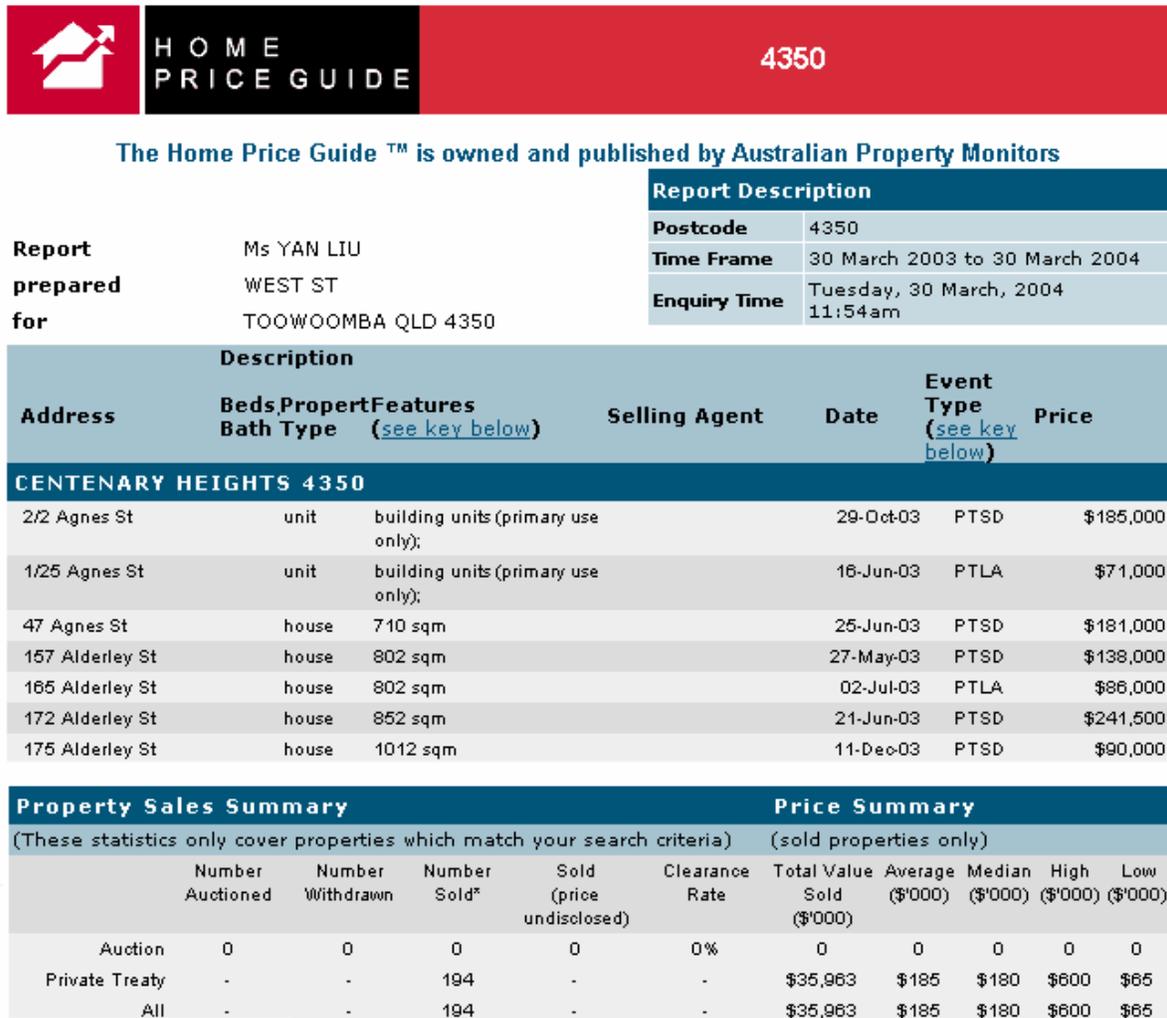
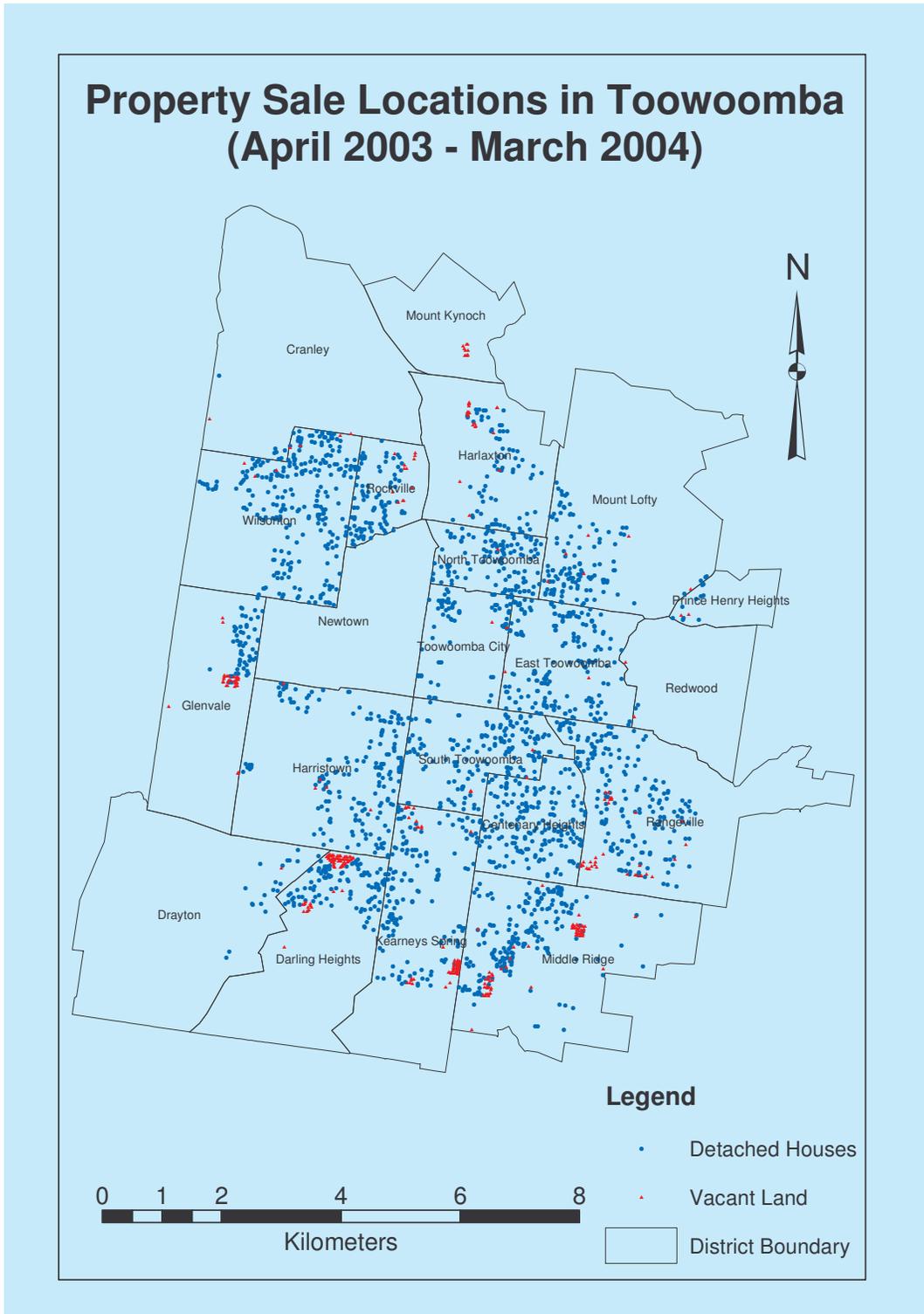


Figure 3.8 A Sample of the Property Transaction Data from the Home Price Guide™



**Figure 3.9 Property Sale Transactions in Toowoomba
(April 2003 – March 2004)**

3.3.5 Other miscellaneous data

The miscellaneous data include regulatory data such as zoning plans, photos and aerial photograph and satellite imageries. For Toowoomba region, the urban zoning is classified into six classes. They are: industrial area, commercial area, urban, rural, conservation area, special purposes area and sports/recreation/open space areas (Figure 3.10). In addition, an ortho photo of the region in 2000 was also collected from the Toowoomba City Council which can be used in the real estate information system as background imagery (Figure 3.11).

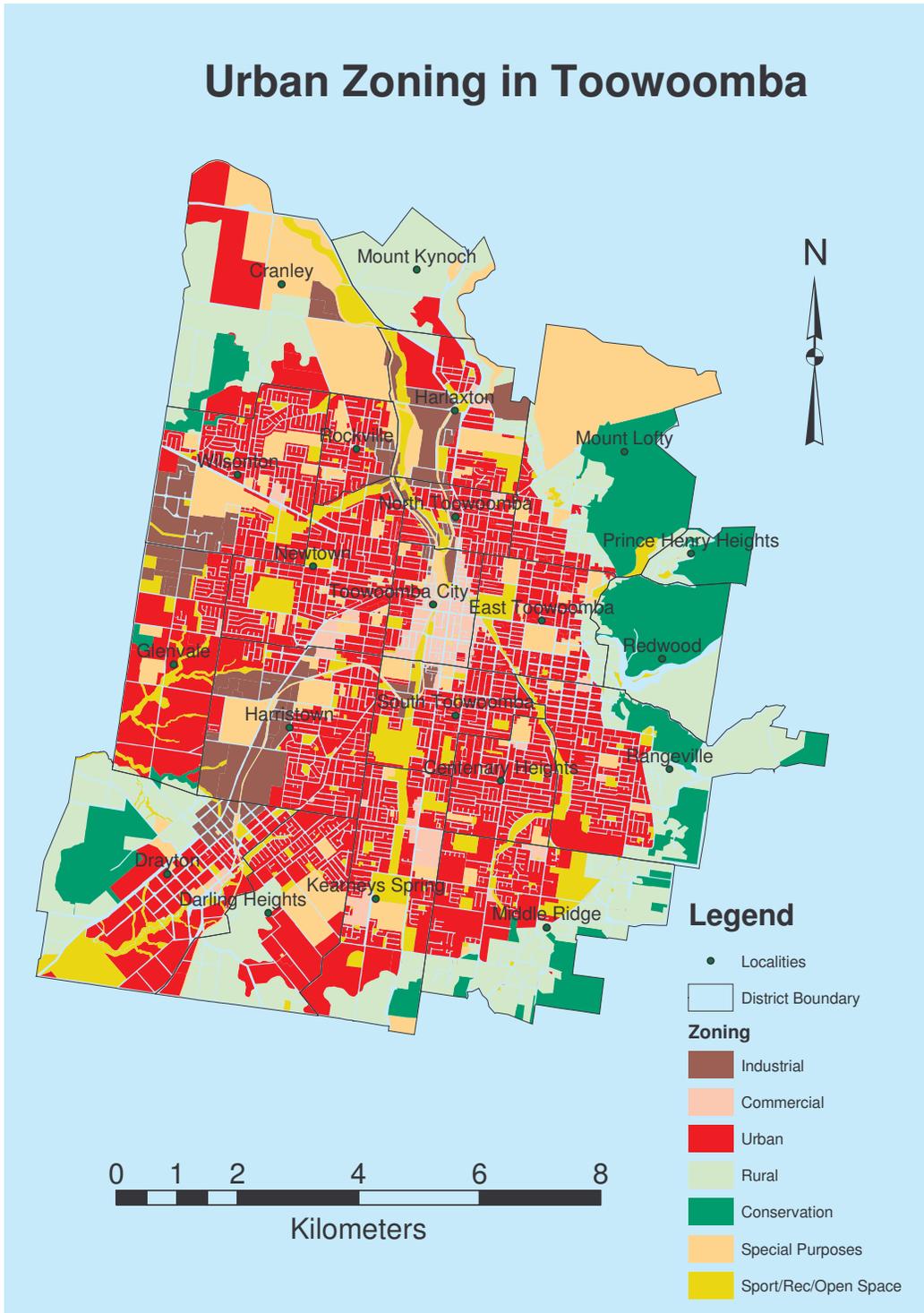


Figure 3.10 Urban Zoning in Toowoomba

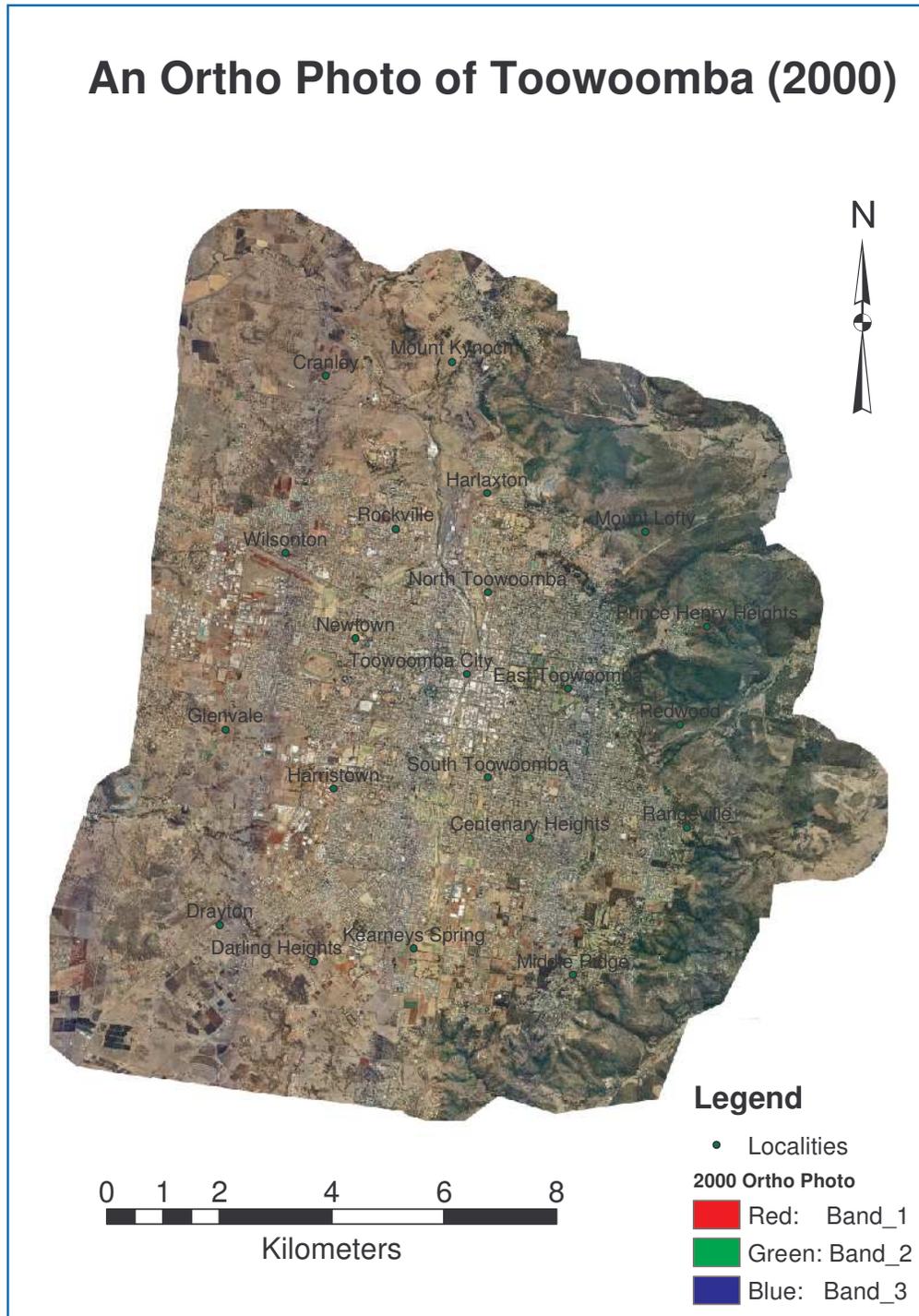


Figure 3.11 An Ortho Photo of Toowoomba in 2000
(Source: Toowoomba City Council)

Apart from the above datasets, photographs for individual houses that are listed for sale were taken and integrated into the real estate information system, which will be discussed in more detail in the following chapters.

3.4 Data processing

Most of the input datasets discussed above were collected from different sources. Therefore, the format of the datasets and their spatial projections may not be the same. In order for the datasets to be used in one GIS program, data processing is required to convert the data into one common data format and projection. The processing of the original data in this project included data input and format conversion, data projection as well as geocoding the tabular data of property listing into the spatial object features.

3.4.1 Data import and conversion

There are a number of different data formats in the spatial information industry. These include shape files, MapInfo Tables, Arc/Info coverages, ArcGIS's geodatabases, and so on. Different data sources may provide data in different data format. In this project, most of the dataset were provided as Shape files, so shape file was used as the common data format for this project. However, some other datasets such as the population and demographic data extracted from the Censuses were in MapInfo table format, and needed to be converted into shape files. This was done first by using the MapInfo to Arc/Info conversion data conversion tool to convert the MapInfo table into Arc/Info coverage, and then from Arc/Info to shape file using ArcMap. Although this process can be time consuming sometimes, there was no difficulty to complete this conversion technically.

3.4.2 Data projection

Even though data are provided or imported into the same format, they may not align together as they may be in different coordinate systems or projections.

Map coordinates are used to uniquely define the location of objects or features on the Earth. To transform the spatial location of an object on the curved surface of the Earth to a flat sheet or surface (map), map projection is required. Based on the surfaces used and the methods and also the datum used in the transformation, many different map projections exist. Often, the data we have isn't in the map projection we want to use. For instance, all of the geospatial data created since 2000 use the Map Grid of Australia 1994 (MGA94) as the geographic datum, however, some of the previous datasets may still be using the Australian Map Grid (AMG84). This data needs to be converted to MGA94.

Using ESRI's GIS software ArcGIS, one can display data in different geographic coordinate systems and different projections in different data frames, or one can also change the map projections of the datasets on-the-fly and display them in the same data frame as different layers. However, this on-the-fly data projection will not change the projection of the dataset itself. If we need to permanently change the map projection and other coordinate system parameters for a source dataset, we can use the data projection conversion function either in ArcMap or ArcToolbox of the ArcGIS software program. In this project, all data were projected into MGA94 using ArcMap software program. This process was done by following the data projection procedures as required by the software program.

3.4.3 Geocoding tabular data to spatial objects

As previously mentioned, data for previous transaction records were collected from the Home Price GuildTM in HTML format. The data were first extracted

from the HTML file and saved as a dbase file using Microsoft Excel program. This dbase table was then loaded into ArcMap and was geocoded to the property boundary and street directory datasets using the street addresses associated with the data. This process was already done by the supervisor through a different project and was therefore ready for use in this current project.

However, another tabular data containing the property listing was collected in this project. Using a similar procedure as listed above, this tabular data was manipulated and maintained in a dbase file first, and was then geocoded to the property boundary and street directory datasets as well. This dataset will be used for constant database query, data search and various spatial display purposes in the project.

3.5 Conclusion

This chapter provided an outline of the study area in Toowoomba. Various datasets in relation to the real estate information system that is to be developed in this project were discussed. After collecting the relevant datasets, the conversion of the data format from their original sources to one single GIS format were undertaken. Each of the datasets was stored in GIS as one separate data layer which will be used to facilitate the development and analysis of the real estate information system.

Chapter 4 Software Development and Applications

4.1 Introduction

Previous chapters have discussed the background information on GIS technologies and its application in the real estate industries. Various datasets were collected in Toowoomba City and were converted into GIS for the purpose of developing a GIS software program to assist house-hunters in searching for their dreamed house.

In this chapter, a user-friendly GIS program was developed to manipulate the property listing for sale geographically, to display the property listing in relation to other social and environmental features including topography, transportation, schools and/or shopping centres, and to provide tools for the house hunters to search and inspect properties and make choices without the need of getting into the houses.

The following sections first explain the methodology used in the project, and how the GIS software program was developed. Various application scenarios were provided to test the program developed. It proves that the GIS program developed in this project provides a good and convenient option in the search of properties based on different selection criteria.

4.2 Methodology

This project uses ArcView 3 as its application software or as a platform for software development. Although the use of ArcGIS 8 software program was also explored, it appears that ArcGIS 8 is more expensive and difficult for the real estate agents or practitioners to purchase and operate. To this end, ArcView 3 is much cheaper and it also provides all functions and tools that will

be needed in this project. In addition, additional functions or tools can be developed and added into the existing interface through the use of its programming language – the Avenue. Therefore, ArcView 3 was chosen as the base program in this project.

The GIS program was developed in three stages. The first stage is in project planning, that is, to identify what functions will be required by the program and how they are to be incorporated into the software program. To do this, first is to become more familiar with the existing functions and tools in ArcView 3 and then to identify what other functions are needed in this project. Although the author has had a long time experience in using this software before, programming using Avenue is still quite new to me. However, I am willing to take this challenge and believe that I will be proficient by the end of this project.

The second stage is to design the interface of the software program and to write codes using Avenue to integrate the functions required into the ArcView software program. The datasets collected and processed in Chapter 3 are used to develop the program for the Toowoomba region. However, the software program can be applicable to other regions if similar datasets can be used for those regions.

In the third stage, the software program developed in this project is applied to assist in the search of properties in Toowoomba region. By using different search criteria for the search, the software program is tested which demonstrates that the program is capable of assisting property hunting in the real estate industry. Through this testing process, limitations of the software program and possible improvement solutions are also explored. The following sections will address issues that are raised in each of these three stages in the program development.

4.3 GIS software development

This section discusses issues raised in the first two stages, that is, project planning as well as software development. The following sub-sections will address these issues in detail.

4.3.1 Project planning

Any successful GIS project starts out with a good strategic plan. Setting up a GIS without a strategic plan is like establishing a corporation without a business plan (Digital Geographic Research Cooperation 2005).

“GIS is an expensive proposition, far more so than at first sight. The bulk of costs are not in the software and hardware systems — which typically get the lion's share of attention and decision-making angst — but the data. Similarly, benefits are produced not by the system alone, but by the intelligent design of analytical processes that generate useful and accurate information. If the system produces erroneous outputs, the investment in it is a waste, and the pretty maps on the wall are a farce. Planning requires that you understand your needs, and take appropriate steps to have the system address them.

For these purposes, a strategic plan is not a formal statement of mission, goals and objectives. The goals and other factors (e.g. data availability) are taken into consideration, to determine priorities in data development and system deployment.” (Digital Geographic Research Cooperation 2005).

According to Pal (2005), there are three issues that need to be considered before a new GIS is developed. They are:

- 1) How do you do business now?
- 2) What do you need to do business in the future?
- 3) How can you do business better in the future?

The development of a GIS based information management system that will meet the requirements of an entire organization, and be flexible enough to meet future growth, requires a structured approach to answer these questions. To successfully implement a GIS in an organisation, there are fourteen steps of events which need to be implemented in the following sequence (Pal 2005):

- 1) Conduct a Requirements Analysis
- 2) Develop a Pilot Project as proof of concept
- 3) Design logical and physical data bases for the land base
- 4) Develop the mapping specification
- 5) Acquire a quality base map
- 6) Set up GIS organization
- 7) Acquire Hardware and Software, and train personnel
- 8) Develop the data base design to support the identified applications
- 9) Develop applications from the prioritized list identified in the Requirements Analysis document
- 10) Develop procedures and standards for data conversion
- 11) Convert data to support applications being developed
- 12) Develop data maintenance policies and procedures
- 13) Develop applications for other users and increase the user base over time
- 14) Implement a fully integrated system comprising all departments within the organization, incorporating the programs developed in the previous phases.

4.3.2 Needs analysis

Just as you would not build a house without a blueprint and working drawings, you should not build an information system without a requirements analysis. The most important and the first step in the implementation of a GIS is to conduct a thorough needs analysis. This analysis is the working blueprint for your business information management system (Pal 2005).

The needs analysis serves as the overall project framework by defining who the users will be, what applications are suitable for immediate implementation by the GIS, and what GIS data and base mapping requirements are needed to support those applications. It provides an initial understanding of the level of effort and realistic schedule required to implement the GIS environment envisioned by users. The document forms the initial framework for a common understanding between the client and the consultant in terms of breadth and scope of the envisioned GIS system (Pal 2005).

In this project, the author has conducted a survey by contacting a number of real estate agencies as to what is the typical information their clients would need when they are looking to purchase a property. The following is a list of information that are of interest to most of the clients when they are enquiring on a property.

- 1) General information about the property, including
 - a. property location
 - b. number of bedrooms
 - c. lot size
 - d. price
 - e. age of the property
 - f. type and texture of the property
 - g. general appearance of the property
 - h. etc.

- 2) Information about the niche environment, including
 - a. sold prices of properties within the neighbourhood
 - b. niche landscape
 - c. schools nearby
 - d. transportation means
 - e. shopping centres
 - f. church locations
 - g. etc.

When conducting the needs analysis, all of the three issues raised by Pal (2005) are addressed. These issues include:

- 1) How do we do business in the real estate industry now?
- 2) What do we need to do business in the future? and
- 3) How can we do business better in the future?

Currently, the general practice for the real estate agent to conduct their business is first to provide their client with a list of properties available in their property list (and some properties listed with other agents through multi-listing; however, this is not the full list of properties available on the marketplace.). The clients or the house hunters are told to have a drive-by to see if any of the properties on the list are of interest to them. This drive-by inspection is from the outside only. Only selected properties after the drive-by process will be further inspected from inside with the accompany of the real estate agent.

Three issues can be identified in the practice in the above process. First, as the property listing is not a complete list of all properties available in the marketplace, there is a danger of missing out the ideal property that the client would like to purchase. Therefore, the house hunters would always like to visit as many real estate agents as they can, which makes the process of house-hunting more time-consuming. The second issue is that as there is no information about the appearance of the properties on the property list, the house hunters have to make a drive-by to each of the properties on the list to avoid any potential lost of their dreamed house. However, they will find that most of the properties on the list may not be of interest to them at all just by the look of the property from the outside or their spatial location on the landscape. They wasted their time and energy by visiting these properties that are of no interests to them at all, even though with the assistance of the real estate agent, some of the properties may have already been eliminated from the list based on their selection criteria. Thirdly, there are also dangers in this drive-by process; that is, some properties may be missed out simply because they do not look appealing from its outside appearance.

GIS can be introduced to improve the above situation significantly. With GIS, most of the information required by the house hunters can be incorporated into the GIS and displayed to the clients on their first visit to a real estate agent. All three problems existed in the current practice can be eliminated if a common GIS database and program can be developed and implemented in the real estate industry. For example, with a common GIS database for the real estate industry, all properties listed for sale will be managed in a central database, and all real estate agents will be able to access this central database to provide up-to-date information about property listing to their client, therefore eliminating the danger of missing out the ideal property to their client.

In addition, by maintaining a central database of property listing on a computer based GIS system, information about the geographical and attribute features of the property, together with various photos and video clips of the properties can be stored and displayed on the computers. The house hunters can easily identify the geographical locations of the properties and view the properties from both inside and outside on the computers without the need to actually driving into the field. This can save considerable time in the inspection of properties and also reduce the danger of missing the ideal property that may appear unsatisfactory to their selection criteria just because of its outside appearance. Even though open house inspection is still required before a final decision can be made, these inspections can be limited to only a small number of houses, making the process of house hunting much faster and more enjoyable.

Through the needs analysis, it is obvious that GIS can provide great benefits to the practice of property sale in the real estate industry. With this system in place, house hunters will find that the process of house hunting much easier and faster and more enjoyable and the real estate practitioners will also find it less work for them but more business turnovers. The next section will address specific requirements and functions that GIS can provide to a real estate information system.

4.3.3 GIS functions required in the real estate information system

Based on the needs analysis conducted for a real estate information system, the following GIS functions are considered important to the real estate information system.

4.3.3.1 Spatial query

Spatial query is like asking a question of the GIS based on the spatial or geographical locations of the object(s). It is the ability to select the features of one or more data layers using the features of another data layer. This function can be used to satisfy a search criterion that involves issues of proximity, adjacency, and containment. For example, one might want to search for properties that are within five kilometres from the University of Southern Queensland in Toowoomba. Another example might be finding properties that are 1000 metres away from the Eastern Creek, which may be subject to flooding in the region.

4.3.3.2 Attribute query

Attribute query is a very common function in all GIS. It is like asking a question of the database based on the attribute of the object. For example, one might want to find out all properties in the database with a list sale price of less than \$300,000; or one might want to find all detached houses that are listed for sale. Most commonly, a client may have a number of set criteria to start their search or property hunting. For instance, one may want to look for detached houses with at least three bedrooms that are less than \$300,000 as the listed sale price. These multiple criteria can be easily accommodated in the search engine. Also, the attribute query can be combined with the spatial query functions in GIS to provide more complex query request.

4.3.3.3 Database update

All our query and display of properties are based on the properties listed in our database. Therefore, managing and maintaining an up-to-date property listing database is critical to provide accurate information to the clients. The database needs to be updated once a listed property is sold, or a new

property becomes available for listing. Basic information about the property, including the size of the lot, number of bedrooms, age, type and texture of the property, listed price as well as a description of the general appearance of the property, should be included in the database and be updated periodically and whenever necessary. This data should be best maintained in a master spreadsheet or in a Database (.dbf) file. In addition, the master spreadsheet should also contain a field (or a column) indicating addition photos, images or video clip that may be available to further describe or present the property. This information will be useful when we develop the hotlink function of the program.

4.3.3.4 Geo-coding

Geo-coding is a process that creates a data layer based on address data in tabular form and a reference feature data. It is similar to pin-pointing a point on the street directory. In a real estate information system, the geo-coding function is necessary as every time when a new property becomes available for listing, we need to pin-point the property on the street map based on the street address of the property. This process requires not only the availability of the correct address of the property, but also a property boundary map with information about individual property address in the attribute data. This property boundary map serves as a reference data to conduct the geo-coding process. In this project, the Toowoomba street directory and the DCDB were used as reference data for this purpose.

4.3.3.5 Hotlink to photos, images and video clips

Hot links let you access virtually any data or application directly from a view. A hot link is followed when you click on a feature in a data layer using the Hot Link tool provided by the software program. For example, you might click on a building to display its floor plan, click on a land parcel to review its legal documents, or click on a country to play a video about it.

Hot links have to be defined before they can be used. To do this, you need to first add a field to the data's attribute table, as discussed previously under database update. This field will store the appropriate value for each feature in

the data layer. For example, if your hot link action will be to display a relevant photo when a property is clicked on, you will need to add a field to the property data layer's attribute table to hold the name of the photo that should be accessed for each property, which will be discussed in detail later.

4.3.3.6 Output display

Once the client has searched the database and surfed around the database, he or she might want you to provide an output of the final results to her/him. Therefore, the GIS program needs to provide a function to generate output to the client. The output can be in the form of maps, or report. You may want to display any information that is of interest to the client on the output map or report. The client may use this output as their short listed properties for further inspection and then making decisions accordingly.

In addition to the above functions, there are other functions that will also be very useful to assist the smooth operation of the information system, including zooming in, zooming out, pan, and zooming to selected features, identity, measure, etc. However, these functions or tools are standard GIS tools and are available on all GIS software package. Therefore, these tools or functions are not discussed here.

4.3.4 Graphic User Interface (GUI) design

One of the most important issues to develop a GIS program for the real estate practitioners to use is to have an easy to use interface. This is called Graphic User Interface (GUI) design in GIS.

4.3.4.1 Three steps in GUI design

There are three steps involved in customizing the interface of a GIS, which needs a certain amount of planning. The first step is to understand the needs of the users of the system on the interface. Who will be the users that will be interacting with the interface? What kinds of things do they often want to do? What are their desired end products? What kind of look and feel do they want for the interface? And so on. For the information system developed in this

project, these questions were addressed in the above two sections and these needs and requirements will be incorporated in the interface of the program.

The second step is to design a dummy interface. This is an interface with custom controls but no functionality associated with the controls. For example, the users may click on a button and a message box will appear telling the user what the button will do when the product is finished. This approach gives the user a feel for the final product, making sure that the product is going to be accepted by the users.

Once this has been done, the actual process of writing the code for the buttons and controls will start. Depending on what GIS software what are going to base on, different programming languages may be used. In this project, ArcView's Avenue programming language will be used for writing the code. The code for each of the functions developed in the program will need to be tested and debugged before the users can use the final program. This is the most time-consuming process, which will be discussed in the following section.

4.3.4.2 GUI design using Avenue

This project is developed using ArcView 3. Therefore Avenue is being used to develop the Graphic User Interface (GUI) and to incorporate some of the GIS functions into the GUI.

Just like ESRI's Arc Macro Language (AML) or the Microsoft Visual Basic, Avenue is ArcView's scripting language and is fully integrated with ArcView (ESRI 2004). As Avenue uses the same interface as ArcView, there is no need to learn a new interface; it simply adds a special kind of document called *script* to the normal ArcView interface. It provides an easy-to-use development environment for customizing the ArcView interface. It can be used to change the existing interface of the ArcView program, or create and add new tools or functions for specific applications. It can also be used to customise the GUI and to develop applications with custom GUIs.

According to the ArcView Avenue instruction manual, there are three basic steps in customising the GUI. The first step is to create new controls or modify existing ones. The second step is to write scripts to perform the new tasks that one propose. Instead of writing all scripts from scratch, one can reuse and edit the system scripts that come with the software if appropriate. The third step is to assign the new script to run when the control is used. Once these three basic steps are completed, the new GUI will be ready for use.

4.3.4.3 GUI for Toowoomba Real Estate Information System

For this project, the new GUI looks like Figure 4.1.

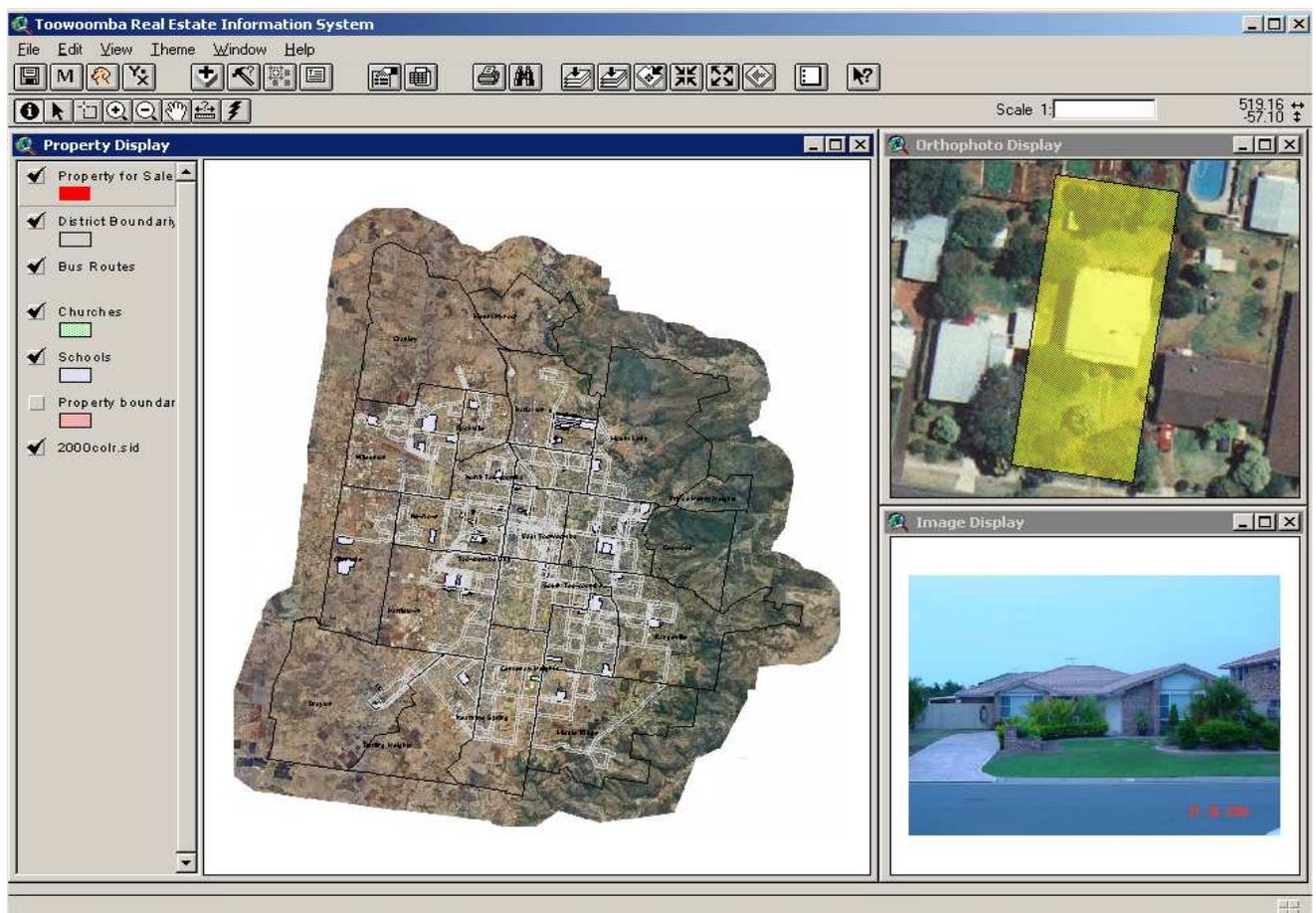


Figure 4.1 The GUI of the Toowoomba Real Estate Information System

Compare to the conventional GUI of an ArcView program, there are a few changes on the interface in this program. The first change that can be identified is on the application attributes of the program. Among them are the

name, location and size of the application window. The name of the program has been changed to 'Toowoomba Real Estate Information System'. There are three view or display windows within the program. On the left hand side is the main window of the program named 'Property Display', and on the right hand side are two smaller windows named 'Orthophoto Display' and 'Image Display' respectively. The Property Display window provides an overview of the study area – Toowoomba. It displays data of the properties for sale, district boundaries, bus routes, locations of churches and schools, and an orthophoto of the area. Other datasets can also be added into this display view, if the datasets are available and are of interest to the clients. The Orthophoto Display window provides a zoom-in view of the property selected from the main window, and the orthophoto as a background image of the area. The Image Display window is designed to display a front view photo of the property being selected from the main window. Other photos and/or video clips can also be linked through the Hotlink tools, which will be discussed later. The Avenue Script for this change is as follows:

Table 4.1 Sample Avenue Script (1)

av.SetName("Toowoomba Real Estate Information System")
av.Resize(980,730)
av.MoveTo(5,5)
myView2 = av.GetProject.FindDoc("Orthophoto Display")
myView2.GetDisplay.InvalidDate(true)
myView2.GetWin.MoveTo(650,0)
myView2.GetWin.Resize(320,300)
myView2.SetTOCWidth (0)
myView2.SetTOCUnResizable(false)
'myView2.GetWin.Open
myTheme2 = myView2.FindTheme("Properties.shp")
myTheme2.SetActive(true)
myTheme2.Setvisible(true)
myTheme1 = myView2.FindTheme("2000colr.sid")
myTheme1.SetActive(false)
myTheme1.Setvisible(true)

'myView2.InvalidateTOC(nil)
myView2.GetDisplay.Invalidate(true)
aTOC = myView2.GetTOC
'aTOC.SetOrderLocked(true)
'av.GetProject.SetModified(true)
myView2.GetWin.Open
myView3 = av.GetProject.FindDoc("Image Display")
myView3.GetWin.MoveTo(650,300)
myView3.GetWin.Resize(320,300)
myView3.SetTOCWidth (0)
'myView3.SetTOCUnResizable(True)
myView3.GetWin.Open
myView1 = av.GetProject.FindDoc("Property Display")
myView1.GetWin.MoveTo(0,0)
myView1.GetWin.Resize(650,600)
myView1.GetWin.Open
av.GetProject.GetWin.MoveTo(-300,-300)
'av.GetProject.GetWin.Open
av.GetProject.SetModified(true)

The second area where changes occurred on the GUI is the new tool buttons added to the interface. These include the program start up tool , the database maintenance tool , the geo-code tool , database update tool , and the print tool . The program start up tool  is used to set the program location, and to line up the three display windows when executed. The database maintenance tool  is designed to maintain the property records of the database. The geo-code tool  is used to geo-code the property record data on the property boundary map. The database update tool  can be used to easily add new property records to the

database when there are new listing data available. And the printing tool  is designed to print out a map layout when produced.

In addition, the spatial query  and attribute query  tools are modified to suit the needs of this program and their locations on the GUI re-arranged.

The third major change in the program GUI is the addition of the hotlink tool . This hotlink tool is available for both the Property Display window and the Orthophoto Display window. Once executed from the Property Display window while the 'Property For Sale' data theme is active, a Orthophoto display of the selected property will be displayed in the Orthophoto Display window. An Avenue script for this Hotlink tool is listed in Table 4.2.

Table 4.2 Sample Avenue Script (2)

theVal = SELF
if (not (theVal.IsNull)) then
theVal1 = "c:\Research\Property\"+theVal+".jpg"
if (File.Exists(theVal1.AsFileName)) then
aGoodImage = ISrc.IsValidFileName(theVal1.AsFileName)
if (not aGoodImage) then
MsgBox.Info ("Invalid Image File", "")
else
'get the image file off the disk
theSrcName = SrcName.Make(theVal1)
theImageSource = ISrc.Make(theSrcName)
theTheme = ITheme.Make(theImageSource)
myView3 = av.GetProject.FindDoc("Image Display")
for each t in myView3.GetActiveThemes
myView3.DeleteTheme(t)

end
myView3.AddTheme(theTheme)
theTheme.SetVisible(true)
theTheme.SetActive(true)
'Zoom to Theme
r = Rect.MakeEmpty
r = r.UnionWith(theTheme.ReturnExtent)
if (r.IsEmpty) then
return nil
elseif (r.ReturnSize = (0@0)) then
myView3.GetDisplay.PanTo(r.ReturnOrigin)
else
myView3.GetDisplay.SetExtent(r.Scale(1.1))
end
'Zoom to Theme code ends
' myView3.GetWin.Activate
myView3.GetDisplay.invalidate(true)
myView2 = av.GetProject.FindDoc("Orthophoto Display")
'av.GetProject.SetModified(true)
theView = av.GetProject.FindDoc("Property Display")
r = theView.ReturnUserRect
theThemes = theView.GetActiveThemes
if (r.IsNotNull) then
p = theView.GetDisplay.ReturnUserPoint
if (System.IsShiftKeyDown) then
op = #VTAB_SELTYPE_XOR
else
op = #VTAB_SELTYPE_NEW
end
for each t in theThemes
if (t.CanSelect) then
t.SelectByPoint(p, op)

end
end
else
if (System.IsShiftKeyDown) then
op = #VTAB_SELTYPE_OR
else
op = #VTAB_SELTYPE_NEW
end
for each t in theThemes
if (t.CanSelect) then
t.SelectByRect(r, op)
end
end
end
av.GetProject.SetModified(true)
theTheme3 = theView.FindTheme("Property for Sale")
if (theTheme3.CanSelect) then
r = r.UnionWith(theTheme3.GetSelectedExtent)
end
if (r.IsEmpty) then
return nil
elseif (r.ReturnSize = (0@0)) then
myView2.GetDisplay.PanTo(r.ReturnOrigin)
else
myView2.GetDisplay.SetExtent(r.Scale(1.1))
end
end
end
end

If the hotlink tool is executed from the Orthophoto Display window, another Avenue script will be executed, as is listed in Table 4.3. Once executed, any photos or images or video clips that are linked to the selected property will be displayed in a separated program, depending on the format of the file linked to

the database. For example, if the file is in PDF format, the Adobe Photoshop program will be executed to run this file; the windows media player will be executed if the file linked to the database is a video clip.

Table 4.3 Sample Avenue Script (3)

theVal = SELF
if (not (theVal.IsNull)) then
theVal2 = "c:\Research\Property\"+theVal+".wmv"
theVal3 = "c:\Research\Property\"+theVal+".asf"
theVal4 = "c:\Research\Property\"+theVal+".pdf"
end
av.GetProject.SetModified(true)
if (File.Exists(theVal2.AsFileName)) then
System.Execute("C:\Program Files\Windows Media Player\wmplayer.exe" ++theVal2)
else if (File.Exists(theVal3.AsFileName)) then
System.Execute("C:\Program Files\Windows Media Player\wmplayer.exe" ++theVal3)
else if (File.Exists(theVal4.AsFileName)) then
System.Execute("C:\Program Files\Adobe\Acrobat 6.0\Reader\AcroRd32.exe" ++theVal4)
else
MsgBox.Warning("File "+theVal2+" not found.,"Hot Link")
end
end
end

Other than the functions and tools discussed above, some of the common tools or functions that ArcView provides, such as save, zoom in, zoom out, pan, add data theme, and so on, are still kept in the program, as can be seen in Figure 4.1.

4.4 Software applications

To test the software program developed in this project, a number of sample testing were conducted. These tests prove that the software program developed in this project meets the requirements for property searching in the real estate industry. The following sections present four sample scenarios where the Toowoomba Read Estate Information System has been tested.

4.4.1 Updating the property listing database

Initially the property for sale dataset is managed in a spread sheet using Microsoft's Excel program. This dataset was converted into a Dbase file (.dbf) and was loaded into the ArcView program which was named as properties.dbf. This property listing dataset needs to be updated whenever a property has been sold or a new property becomes available to the market. This dataset is maintained by the user of the program, that is, the real estate agents or practitioners. To undertake this task, the user can press the  button on the GUI. Once prompted to enter a search item (Figure 4.2), the user can enter the address of the property to check if it is listed on the property list. If the property is on the property list database and the property has been sold, then the user can change the attribute of the 'Sell Flag' from "For Sale" to "Sold". This way, the sold property still remains on the property listing, but is identified as a sold property. When finished, the user can then go to Table -> Save Edits to save the edits. The Avenue script used to undertake this function is listed in Table 4.4

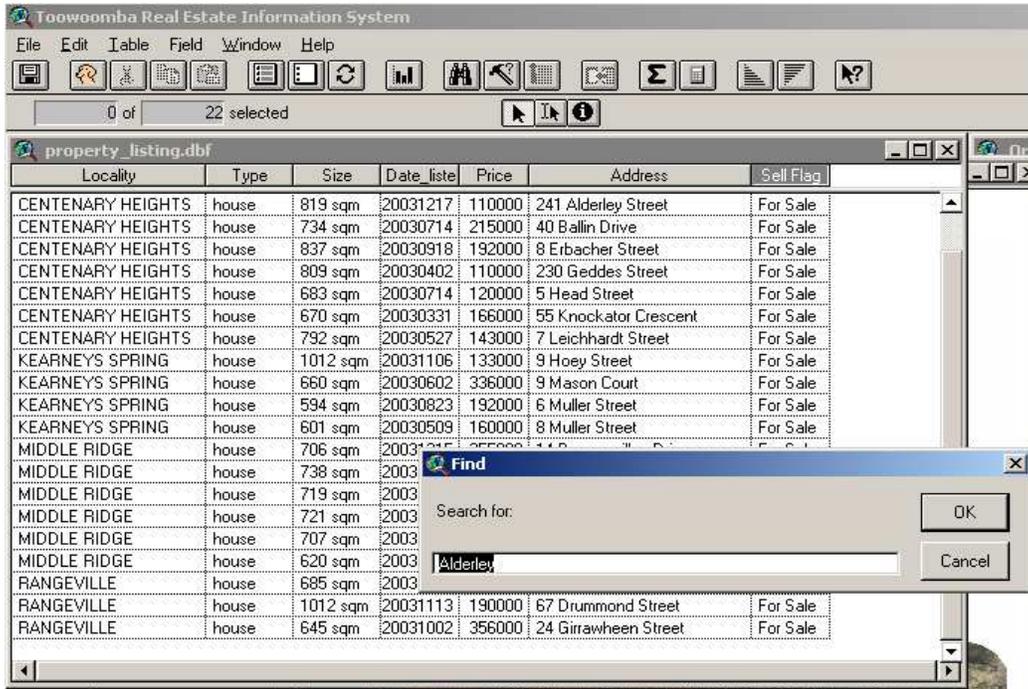


Figure 4.2 Updating the Property Listing Database

Table 4.4 Avenue Script for Property Listing Update

'Start Editing
theTable = av.GetProject.FindDoc("property_listing.dbf")
theTable.GetWin.MoveTo(0,0)
theTable.GetWin.Resize(650,400)
theTable.GetWin.Open
theVTab = theTable.GetVTab
theVTab.StartEditingWithRecovery
'Find record
'theTable = av.GetActiveDoc
key = MsgBox.Input("Search for:", "Find", theTable.GetFindString)
if (key <> Nil) then
rec = theTable.Find(key)
if (rec = Nil) then
MsgBox.Warning("No more matches found.,"Find")
else
b = theTable.GetVTab.GetSelection

b.ClearAll
b.Set(rec)
theTable.GetVTab.UpdateSelection
theTable.ShowRow(theTable.ConvertRecordToRow(rec))
end
end
'Promote found results
'theTable = av.GetActiveDoc
theTable.PromoteSelection

In addition to changing the attributes of the property listing database, the user can also delete a record completely from the database, or add a new record to the database once a new property is available for sale on the market. This function can be completed by using the tools and functions under the Table and Edit Menu of the program.

4.4.2 Geo-coding the property data

Geo-coding function in this program is a bit different from the conventional approach of conducting geo-coding in GIS. As we are not having point data with their geographical coordinates, but the property addresses, and we would like to display the lot boundary of the property rather than as a point, we are actually linking the property listing database with the DCDB property boundary database. By matching the property listing database with the property boundary database, we got to identify and extract those properties in the property listing with the DCDB property boundaries. The extracted dataset becomes a subset of the property boundaries datasets and all the attributes from the property listing database are transferred to the new dataset, and is saved as a new shape file and added into the GIS program. This dataset is loaded as a theme named "Property for Sale".

Although ArcView GIS provides the facilities to conduct this purpose, there are certain procedures which involve a number of steps to complete the task. This may become a problem for the real estate practitioners who have not

much GIS knowledge to complete. To facilitate an easy completion of this task, all the required procedures are sequenced in one script and this script is then associated into a button on the GUI. By pressing the geo-coding button  on the GUI, the user of the program can just following the prompts on the screen to complete the procedure.

4.4.3 Searching/querying the database

Property searching or querying is a major function of this program for real estate industry. This program provides tools to search the database based on the attribute information of the database, or the spatial or location information of set criteria. The following provides test runs based on both categories of selecting criteria.

4.4.3.1 Attribute based search/query

Firstly, the attribute based search can be conducted through the query builder tool of the program. By selecting the tool , a query builder window will appear (Figure 4.3). Users can use this tool to set their selection criteria quite easily.

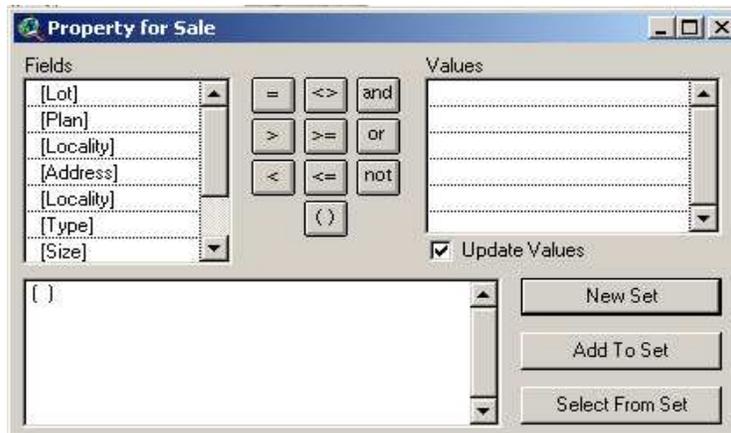


Figure 4.3 The Query Builder Window

For example, we can search all properties with a listed sale prize between \$200000 to \$300000 (Figure 4.4).

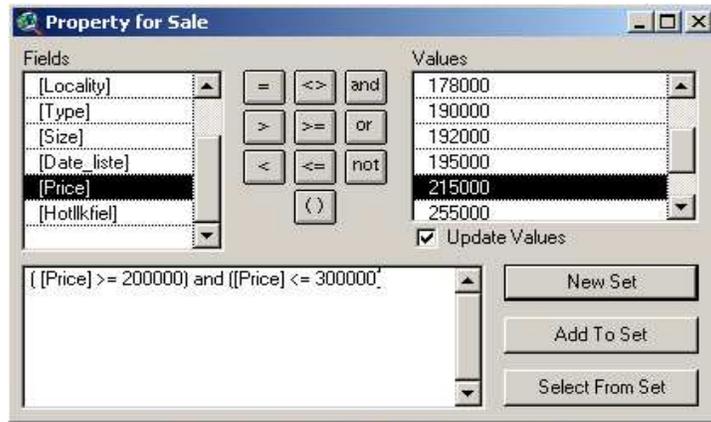


Figure 4.4 Searching the Database

By executing this search criterion, we get four records that satisfy this criterion. We can zoom in to have a closer look of these four properties by clicking the Zoom to Select button . The selected properties are highlighted in yellow colour (Figure 4.5).

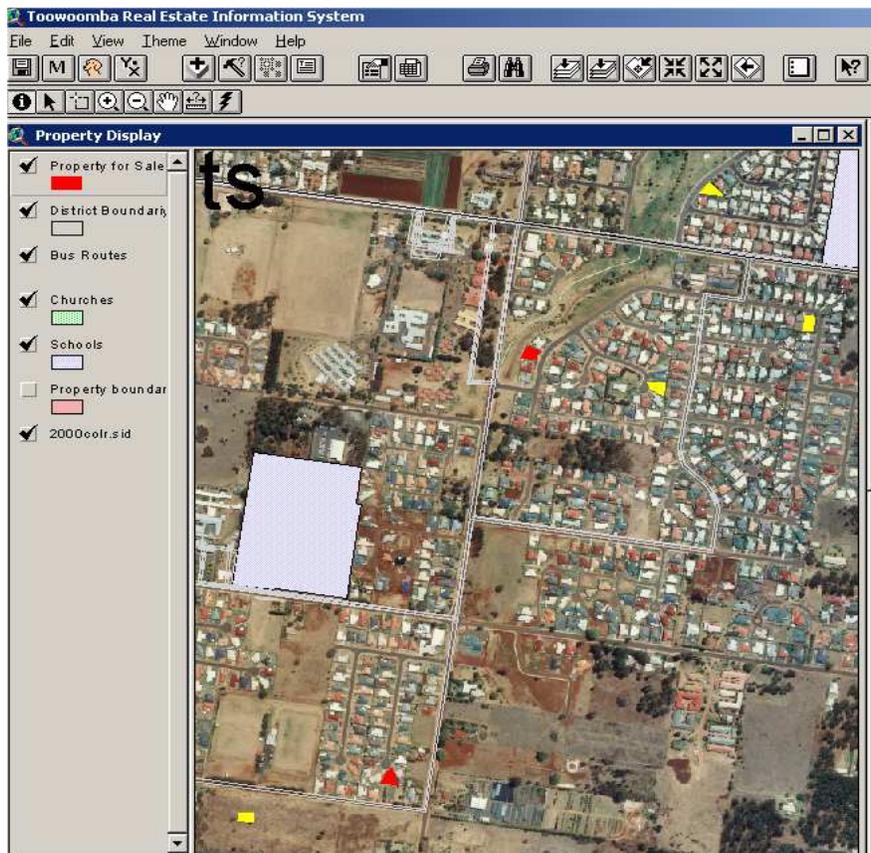


Figure 4.5 A Display of the Selected Properties

Now, using the Hotlink button , the user can select each of the properties to have a more detailed look of the property and its surrounding area by looking at the two smaller windows on the right hand side of the program interface (Figure 4.6). By making the Orthophoto Display window active, the user can also use the Hotlink tool to select the property and display other photos or video clips if there are other photos or video clips associated with the property.

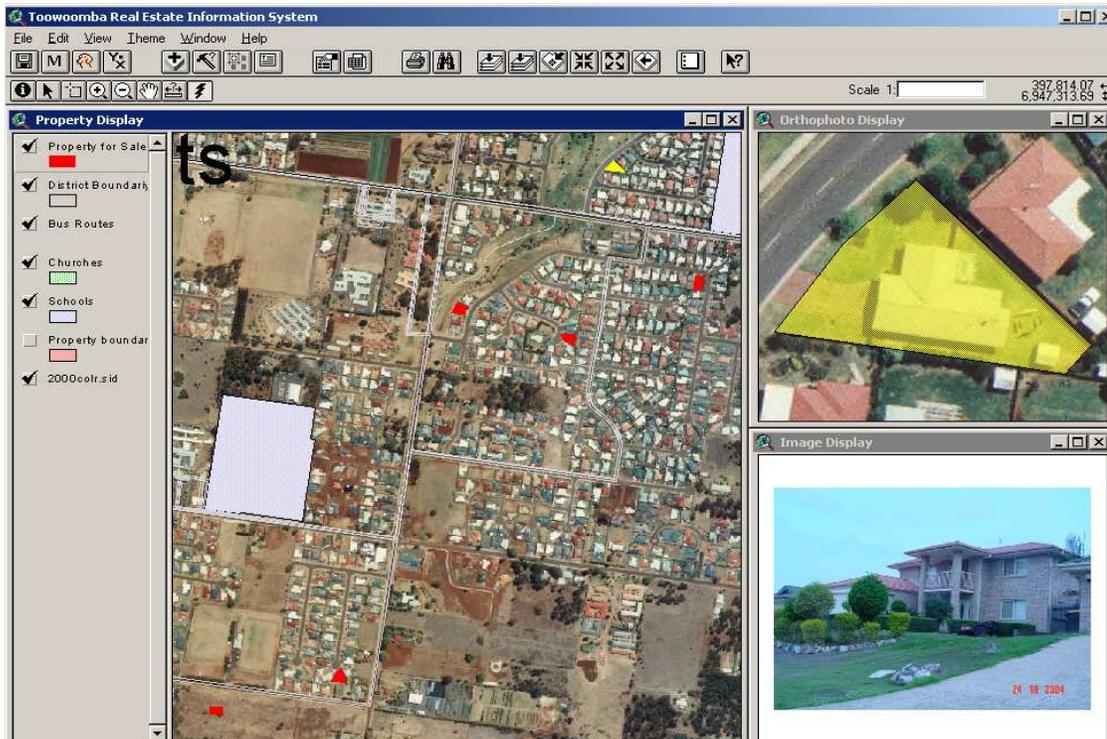


Figure 4.6 A Zoom-in Look of the Selected Property

Using the Query Builder, the users can not only apply one criterion to conduct the search of the database, they can also apply multiple selecting criteria to conduct the search, or they can apply further selecting criterion to search the selected properties. For example, one can search the property list with listed sell prize with A\$200000 and A\$300000 and also have four bedrooms and double garages. In this case, the Query Builder will look like in Figure 4.7.

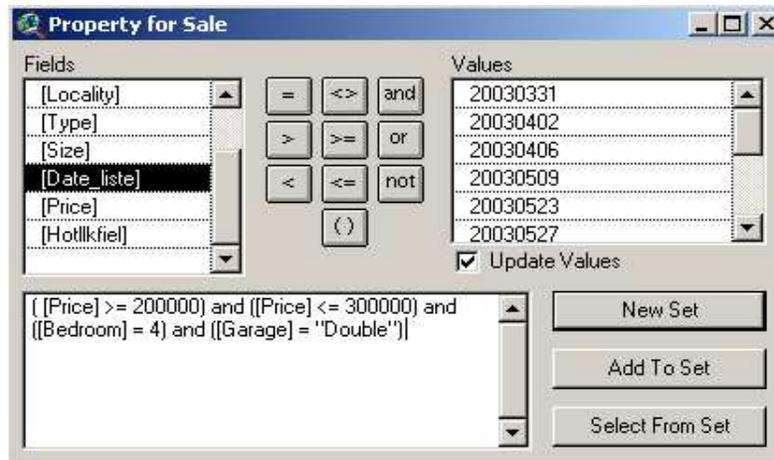


Figure 4.7 Building a Multiple Criteria Query

4.4.3.2 Spatial based search/query

This function is designed to search properties based on the spatial location or adjacency of the property to other spatial entities, such as schools, churches or shopping centres. Once this function is build, the interface to undertake this function will be similar to the function provided by ArcGIS 8 (Figure 4.8). However, due to the time limit in submitting this project thesis, the tool to conduct this function has not been developed in the current version of the program.

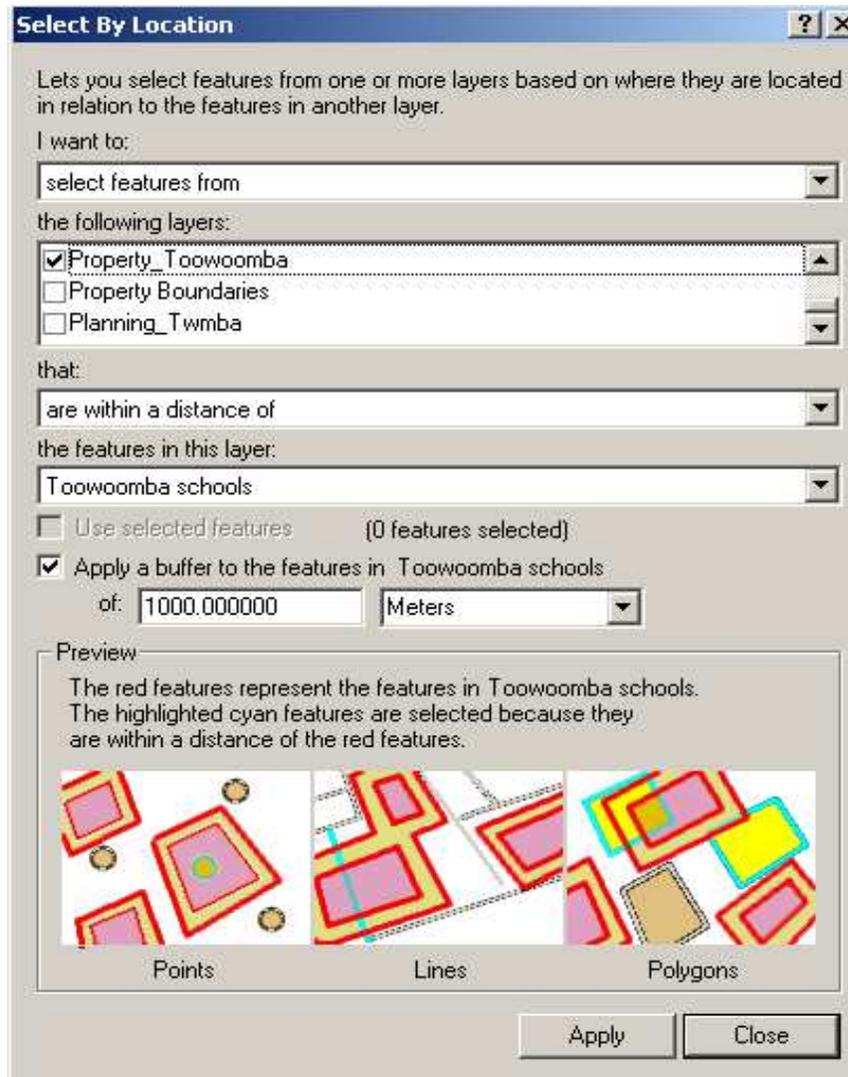


Figure 4.8 A Similar Function Available in ArcGIS 8

4.4.4 Presenting results

The presentation of the searched results by the property hunter can be done in a number of different ways, depending on the requirement of the users. One of the common ways of presenting the results is to produce a layout of the main view of the window and print a copy of the layout. This can be done by selecting View → Layout, then produce a layout with selected properties and other relevant environment data on the view (Figure 4.9). This layout can be printed by pressing the print layout button , which is available on the GUI.

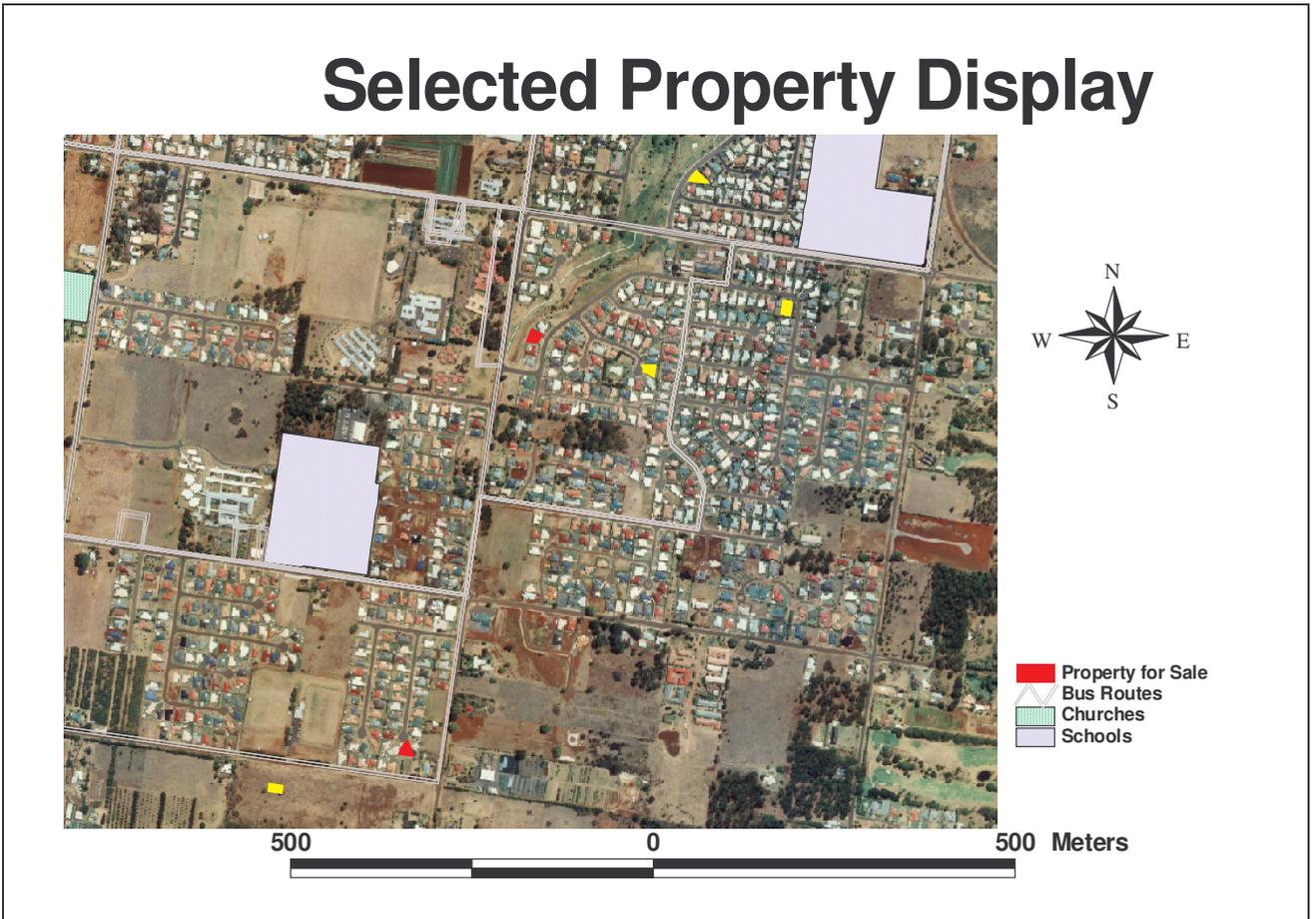


Figure 4.9 A Sample of Layout to Present Selected Properties Results

4.5 Conclusion

This chapter presented research on the development and applications of a real estate information system in Toowoomba. Methodologies used in the research was outlined and discussed, followed by project planning and needs analysis. The needs analysis is important which provided a clear picture as to what functions and tools will be required in the real estate information system. Major functions provided in this project, including spatial and attribute query, database maintenance and update, geo-coding, hotlink to other data and output display are explained and discussed, which are available for use

except for the spatial query function. All these functions and tools are integrated into one single easy-to-understand, easy-to-use interface, that is, the Graphical User Interface (GUI).

All the functions and tools developed in this program are tested and a number of testing operations of the program have been undertaken. It demonstrates that all the tools and functions are fully functional and it does provide an easy tool for the real estate agents/practitioners and the house hunters to use in their search for properties.

Chapter 5 Conclusions and Further Development

5.1 Introduction

This chapter will provide a summary of major achievements of this project. These major achievements reflect the aim and objectives and the expected outcomes well. In addition, the strengths and limitations of the GIS program developed in this project will also be discussed, which lead to the discussions on further research and development in the subject area in the future.

5.2 Summary of Achievements

According to the objectives of this project as set out in Chapter 1, the following outcomes have been achieved.

- An comprehensive review on literatures in the area of GIS applications in business and in the real estate industry in particular have been undertaken and was documented in Chapter 2 of this dissertation;
- Various datasets for the development of a real estate information system in Toowoomba have been collected and processed. These datasets were used in the development and application of the real estate information system in Toowoomba;
- A user-friendly GIS software program for real estate property listing search and display in Toowoomba region has been developed;
- Various application scenarios of the software program developed in this project have been presented in Chapter 4. It proved to be useful

and usable to assist both the house hunters and the real estate practitioners to find or sell the properties they want;

- The next section of this chapter will discuss the strengths and limitations of the program in its current version. Further research directions in the application of GIS in property hunting practice will also be provided.

5.3 Further Development

Due to the time limit in developing this program, there are a number of limitations in the development and use of this software program. One of the major issues in limiting the usage of this program is that it is based on ESRI's ArcView 3 software program. Therefore, the users who wish to use this program in managing their real estate database and provide services to their clients will need to purchase ArcView 3 from the vendor, even though the price for this software is relatively cheap after the launch of the ArcGIS software program. Ideally, the author would like to use Open Source GIS to develop a real estate information system so it can be independent to any of the software vendor, and the users will not need to purchase other software if they want to use this program. This will be the future task of the author.

Also, the software developed in this project is limited in its way of coding using Avenue script language. As the author has just started learning this language since starting this project, a lot of the coding was done using 'hard coding', that is, the file names of the database were coded into the program without giving the users the option to select the file name when they want. However, this problem can be easily fixed when time permit, which will also become one of the tasks for the next version of the program, that is, to fine-tune the program to better suit the users' needs.

The third area where improvement is required is that some of the functions required for the program are not available at the current stage. This is mainly

in the spatial search function that should be useful for the identification of properties by the house hunters. The author will endeavour to finish this task in the near future.

Overall, the GIS program developed in this project proved to be a success and it can be used in the real estate industry for property hunting purpose, although further fine-tune and improvements to the current version of the program are still on-going. The current project satisfies the aims and objectives as set up in the project proposal and specification.

List of References

- Australian Bureau of Statistics 2005, *Housing Finance, Australia (5609.0)*, Australian Bureau of Statistics.
- Australian Bureau of Statistics 2000, *CDATA 2000*, Australian Bureau of Statistics.
- Al-Husaini, AH 1997, Using GIS in Real Estate Transactions, Available at <http://www.gisqatar.org.qa/conf97/links/q2.html>, last accessed 5 March 2005.
- Barnett, PA and Okoruwa, AA 1993, Application of Geographic Information Systems in Site Selection and Location Analysis. *The Appraisal Journal*, April, 245-253.
- Bernhardsen, T 2002, *Geographic Information Systems: an introduction*, 3rd ed. New York: John Wiley & Sons.
- Burrough, P 1986, *Principals of Geographical Information Systems for Land Resources Assessment*. Oxford: Oxford University Press.
- Castle, GH (ed.) 1998, *GIS in real estate: integrating, analyzing, and presenting locational information*. Chicago: The Appraisal Institute.
- Dale, PF and McLaren, RA 1999, GIS in land administration. In Longley, PA, Goodchild, MF, Maguire, DJ and Rhind, DW (eds.), *Geographical Information Systems, Vol. 2 Management Issues and Applications*, pp.859-875. New York: John Wiley & Sons.

- Daniel, L 1994, GIS Helping to Reengineer Real Estate, *Earth Observation Magazine* (November). Also available at <http://www.colorado.edu/geography/gcraft/notes/gisapps/reengr.html>, last accessed 5 December 2004.
- Digital Geographic Research Cooperation 2005, Planning for GIS. Available at <http://dgrc.ca/services/planning/plan101.html>, last accessed 5 May 2005.
- DNR&M 2004, SmartMap Queensland, Available at <http://www.nrm.qld.gov.au/property/mapping/blinmap/index.html>, last accessed 8 May 2005.
- ESRI 2004, Geography Matters in Real Estate, available at: http://www.esri.com/industries/real_estate/index.html, last accessed 15 July 2004.
- Hyde, R 1991, The feasibility of a land information system for Belize, Central America. *International Journal of Geographical Information Systems*, 5(1):99-109.
- Inglis, MJ 2002, *The use of GIS to identify developable land*, unpublished dissertation, October 2002, The University of Southern Queensland, Toowoomba.
- Landis, J 1998, An overview of GIS technology in real estate. In Castle, GH (ed.), *GIS in real estate: integrating, analyzing, and presenting locational information*. Chicago: The Appraisal Institute.
- Lin, C., Meng, L. and Pan, H. 2001, Applications and research on GIS for the real estate, paper presented at the 22nd Asian Conference on Remote Sensing, 5-9 November, 2001, Singapore.

- Ling, DC. and Smersh, G. 1996, Retail Site Selection Using GIS: An Introduction to Methods, Models, and Data Sources, in Benjamin, J. (ed.), *Megatrends in Retail Property*. Boston: Kluwer.
- Liu, Y. 2004, Mapping the spatial differentiation of property sale prices in an urban environment, *Proceedings of the Map Asia 2004 conference*, Beijing, 26-29 August 2004.
- Mao Chiu Dik, W 2003, *Real estate Geographic Information Systems (GIS) for urban redevelopment through the perspective of a real estate developer*, unpublished dissertation, June 2003, The University of Hong Kong, Hong Kong.
- Pal, AB, 2005, Implementation of a Geographic Information System (GIS) – The Nuts and Bolts, Available at <http://www.gisdevelopment.net/technology/gis/techgi0012.htm>, last accessed on 2 April 2005.
- Quiambao, RB 2001, GIS analysis and cartographic presentation of a site selection problem. Paper presented at the 22nd Asian Conference on Remote Sensing, 5-9 November 2001, Singapore.
- Thrall, GI 1998, GIS application in real estate and related industries. *Journal of Housing Research*, 9(1):33-59.
- Thrall, GI 2002, *Business geography and new real estate market analysis*. New York: Oxford University Press.
- Toowoomba City Council 2003, *Toowoomba – Facts and Figures*, Edition 11, June 2003.

Wyatt, P 1996, The development of a property information system for valuation using a Geographical Information System (GIS). *Journal of Property Research*, 13:317-336.

Yeh, GO 1991, The development and applications of Geographic Information Systems for urban and regional planning in the developing countries. *International Journal of Geographical Information Systems*, 5(1):5-27.

FACULTY OF ENGINEERING AND SURVEYING
ENG 4111/2 Research Project

PROJECT SPECIFICATION
Issue A, August 2004

FOR: Tao Jin
TOPIC: GIS for House Hunters: a case study in Toowoomba
SUPERVISOR: Dr Yan Liu

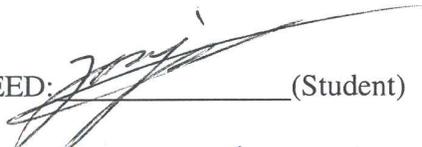
PROJECT AIM: The aim of this project is to demonstrate how GIS can be used to help house hunters to identify their dream homes using Toowoomba as a case study area.

Background and Tasks:

House hunting is one of the most important but time-consuming activities for many families in Australia and worldwide, which also involves difficult decisions to make. Currently, the process of looking for house requires looking and inspecting individual houses through the guild of real estate agents. This is a time consuming process, and even though, the house hunters may still miss out the ideal house they want. The project aims at demonstrating how GIS can be used to help house hunters to identify and choose their dream homes.

The tasks to be completed in this project include:

1. A literature review in the area of GIS applications in business especially in the real estate industry;
2. Research data required for developing a real estate information system;
3. Collect data required for developing a real estate GIS using Toowoomba as a case study area;
4. Develop a house hunting GIS for the study area;
5. Apply the GIS to conduct case study scenarios in house hunting;
6. Write the dissertation on the development and application of the GIS developed in this project.

AGREED:  (Student)

 (Supervisor)

Date: 18 August 2004

23/08/2004