Dunedin Urban Pilot Study
A Hazard Information System

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Abstract

From 1993-1995 the Institute of Geological and Nuclear Sciences Ltd, in collaboration with others undertook research into developing a Natural Hazards Information System using GIS. Papers reporting the progress of the information system were presented at the 1994 and 1995 SIRC colloquiums. But what happened to the system? Where did it go? This paper attempts to answer some of these questions by presenting the latest version of the system and discussing some of the difficulties of developing and using such a system.

By 1995, a menu-based hazard information system in PC Arc/Info™ software had been developed, which was partially functional in that it reported known hazard information, albeit in a somewhat “user-unfriendly” manner. In 1997 the project was re-visited and the user interface upgraded. Initially this involved transferring the textual data to an Access™ database and linking it to the spatial data in ArcView™ GIS software. An application was written using the Delphi™ development environment which handled most of the user input and called ArcView software when it was necessary to display or query the spatial data.

In 1998 we changed tack and made use of the Dialog Designer™ add-in to move the whole system into an ArcView project. The system now consists of one ArcView project that contains a view of the spatial data, a report template and a set of dialogues and associated code. One major problem associated with this system is with the creation of reports, which are a mixture of spatial and textual information.

The work has demonstrated that there is sufficient flexibility and functionality with desktop GIS to allow the customising of a Hazard Information System to meet organisational requirements, albeit with limited reporting functionality. However, the collection of hazard data in digital form is one of the major hurdles that local authorities must cross before they can utilise such a system.

Keywords and phrases: hazard, landslide., mine subsidence, faults, GIS, Dunedin

1.0 Introduction

In 1995 a pilot Hazard Information System was developed for a 64 km^2 area of south-west Dunedin (Figure 1) as part of research undertaken by the Institute of Geological & Nuclear Sciences Ltd (GNS). The work was done in collaboration with the Dunedin City Council, Otago Regional Council, Spatial Information Research Centre (SIRC) at the University of Otago, and the Institute of Valuers (Aldridge & Benwell 1993, Aldridge *et al*. 1993, Glassey *et al*. 1994 and Turnbull & Glassey 1994). The system was developed in PC Arc/Info, but was never fully functional nor easy to use. This, and the large task ahead for local authorities of capturing and digitising hazard data, meant that this system was not adopted by any local authority.

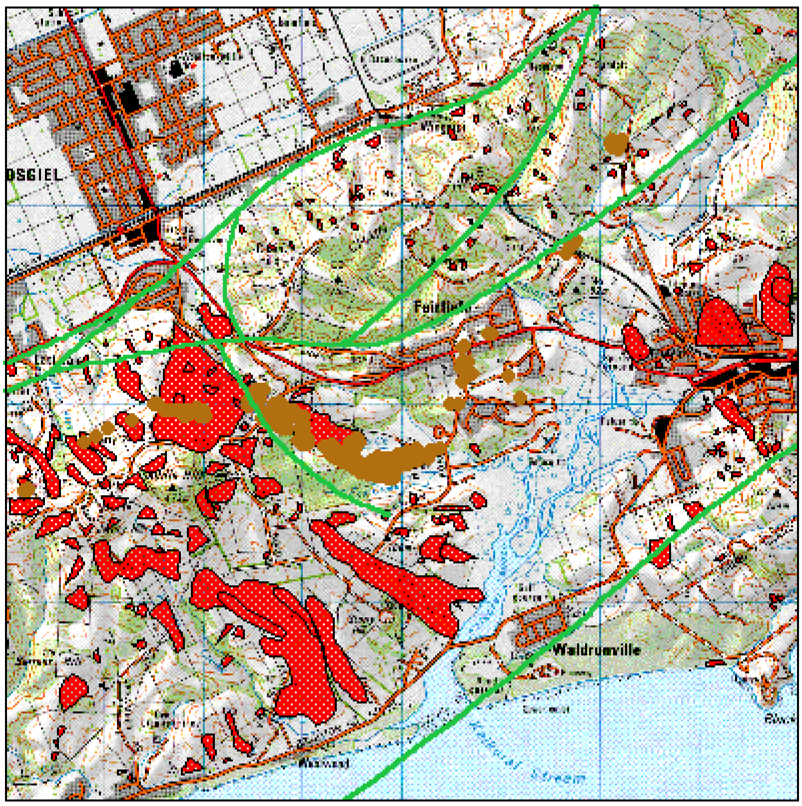

Figure 1 – Area of pilot study

Since that time, the information system has been revisited with the aim of developing a Graphical User Interface (GUI) that will allow the hazard information to be queried by users who are not familiar with complex GIS commands and macro language, thereby making the hazard information more readily available. It was hoped that an outcome of this redevelopment would be the adoption of the information system, or aspects of it, by local authorities to allow them to access hazard information more effectively.

This paper outlines two approaches to developing the interface and the problems associated with doing so.

2.0 Data

2.1 Cultural/Topographic Data

Included within the system are topographic data (contours, streams etc.) purchased from Land Information New Zealand (LINZ, and its predecessor DOSLI), and the Digital Cadastral Database (DCDB, ie. parcel boundaries) and roads provided under license by the Dunedin City Council.

2.2 Hazard Data

2.2.1 The Hazard register

The hazard register includes a database that describe known occurrences of hazards. The hazards included in the system are:

- Landslides,
- Mine subsidence features, and
- Faults,

but any number of hazard layers could be added.

The hazard data come from a number of sources, both within GNS (eg. Bishop & Turnbull 1996 and McKellar 1990) and from Otago Regional Council and Dunedin City Council files. An important aspect of the system is the ability to always be able to return to the source of the hazard information, so that the hazard and the location can be verified or reinterpreted.

2.2.2 Hazard Zonation data

There are three zonation coverages within the hazard system:

- A Landslide Susceptibility Zonation (Figure 2) derived from a combination of slope data (derived from the contour coverage), geology, and groundwater layers. The groundwater layer was modelled from groundwater information held within the drillhole and subsurface database (see Other Data below) and the topographic data.
- A Mine Subsidence Hazard Zonation for a residential area underlain by mine workings. This coverage was derived from work carried out previously by GNS, but it should be noted that the zonation does not cover all areas underlain by mine workings.
- A Fault Buffer Zonation, a 50 m buffer around all known fault traces, which is an attempt to take into account some of the uncertainty of the location of the faults.

2.3 Other Data

Also included within the system are two datasets that can be queried. These are:

- A Drillhole and Subsurface database which includes summary drillhole information and other subsurface information such as test-pits, Calweld shafts etc, and logged batters or sections.
- A Hazard Reference database (Figure 3) which identifies the source of the hazard data, where the material is held and how it can be obtained.

2.4 Management of Data

The spatial data are stored as Arc/Info coverages on a Sun workstation and are accessed by a PC using Samba software. The attribute data for the parcels, landslides, references and subsurface coverages are stored in an Access database. The spatial and attribute data are joined in ArcView. This complex data organisation was primarily required because a relational database model is not readily supported in ArcView.

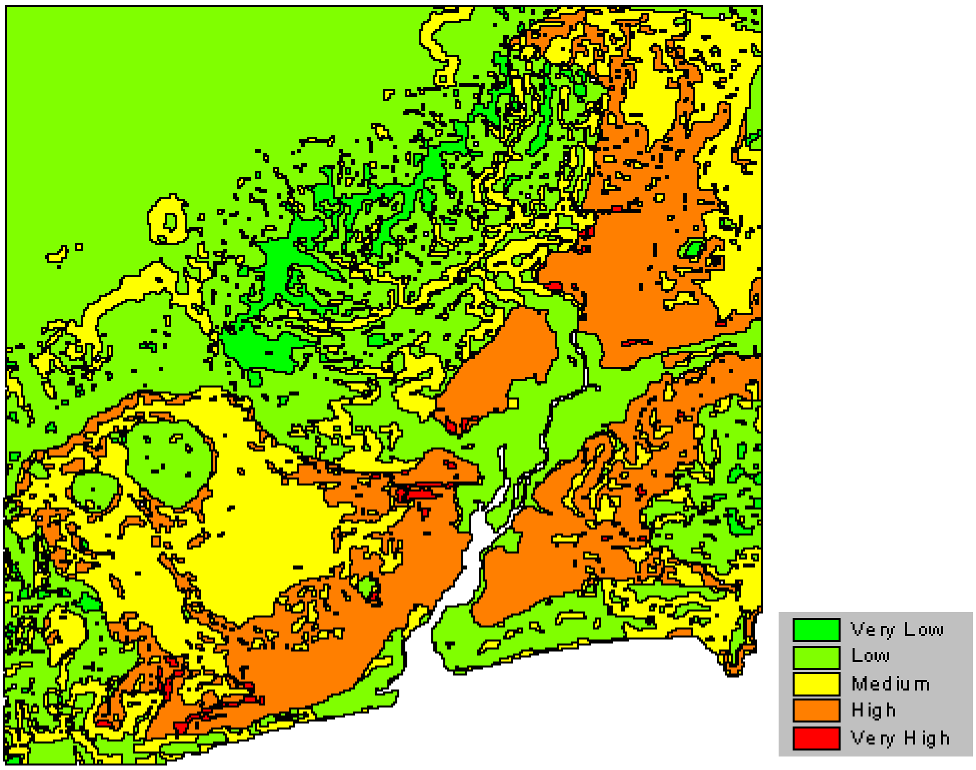

Figure 2 – Landslide susceptibility zonation

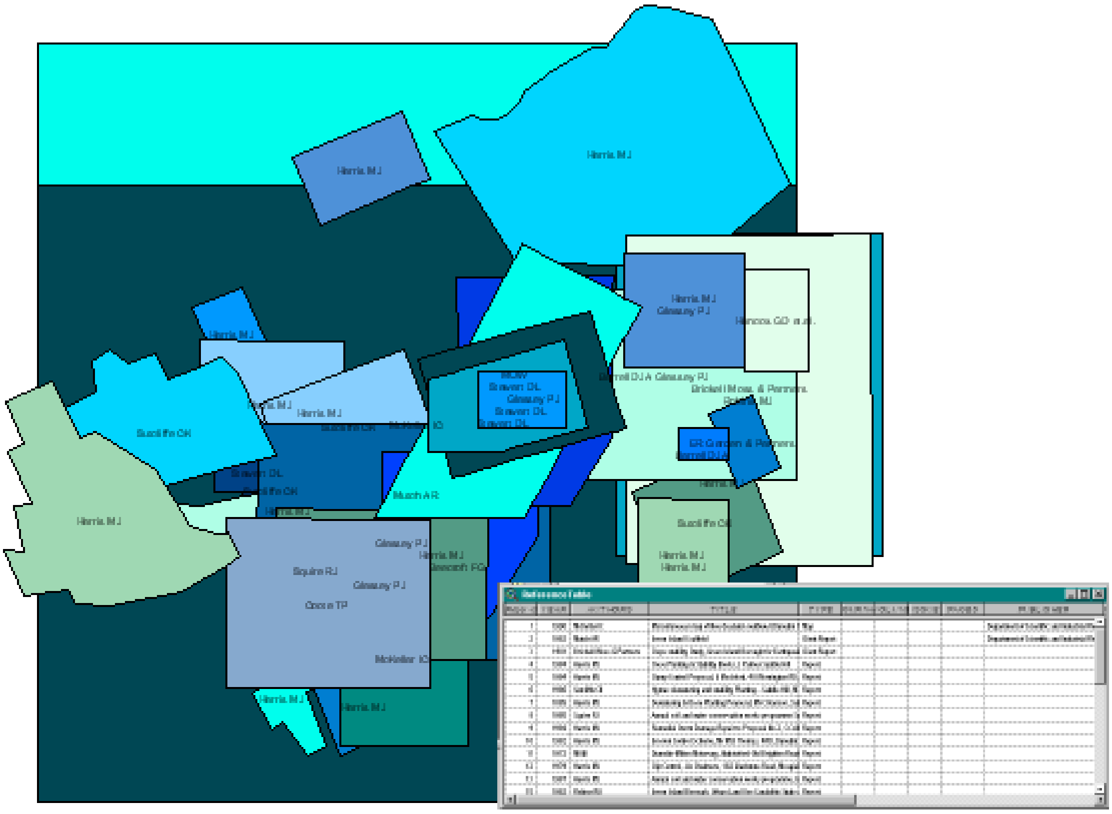

Figure 3 – Hazard references (polygons and associated table)

3.0 System Development Environment

3.1 Prototype 1

A Hazard Information query system was first developed using Delphi, ArcView and Access. ArcView was used for the spatial analysis and display and most of the attribute data is stored in an Access database. It was decided to use Delphi 1.0 as the development tool to create a stand-alone Windows *executable*. When necessary, the programme acts as a Dynamic Data Exchange (DDE) client to ArcView 3.0a. The Access database is accessed through the Borland Database Engine and 16-bit Open Database Connectivity (ODBC) drivers.

3.2 Prototype 2

A second prototype was developed using Dialog Designer, an ArcView add-in, which allows simple dialog menus to be developed and saved in an ArcView project. The dialogs were tied together using Avenue scripts

There are two types of tables stored in the project. Internal tables are from the coverages displayed in the *View* and external tables are from the Access database accessed via ODBC. The external tables are then either joined or linked to the internal tables by appropriate keys.

A start-up script automatically sets the display when the project is loaded and brings up the main menu. From there users can access all ArcView tools and menus and can navigate through the system using the set of *dialogues* and associated Avenue *scripts*.

3.3 Comparison of Development Environments

We initially chose to develop the system using Delphi as this allowed for the rapid development of a flexible and simple GUI and *front-end* to the textural databases. However we still required a way to display and query the spatial data and decided to use ArcView – requiring an interaction between the Delphi application and ArcView, which we achieved with DDE. It became clear early on that there were several bugs in the Delphi DDE components and we tried a third party DDE component called Django. This approach worked satisfactorily, but we felt that the system was made overly complicated having two separate applications with a different *look*. It was also difficult to distribute the application.

At this stage the ArcView Dialog Designer extension was released and the decision was made to migrate to this configuration. This solved the two problems of interaction and portabilitly by having all the code saved in one ArcView project. The combination of Dialog Designer and Avenue scripts, although not as powerful as Delphi, does allow the development of an adequate GUI. The standard ArcView reporting module is very inflexible and it was difficult to develop standard reports. There are third party products available and the latest version of ArcView has a new reporting module, but these were not used.

There was a third option that was identified but not worked on due to financial and time constraints. This option would have used MapObjects™ (a mapping component) and an object orientated development kit (eg Delphi). This would have been the most flexible and powerful solution as we would have been able to build the GUI as in the first prototype, and with the MapObjects component, include all the spatial data.

4.0 The Hazard Information System

The system starts up with a view of the hazard area, showing a topographic map overlain by landslides, subsidence features and fault lines (see Figure 1), and a menu with several choices as described below (see Figure 4):

Select Property

Pressing this button opens the *Select Property* dialogue box. Users can select a property or properties in two ways. The first method is to use the ArcView toolbar to zoom, pan, identify and select properties. As the user zooms in on the map the display changes from a topographic map background to parcel boundaries and road centre-lines. The second method is to select the street name in the drop down box and press the zoom button. This selects all

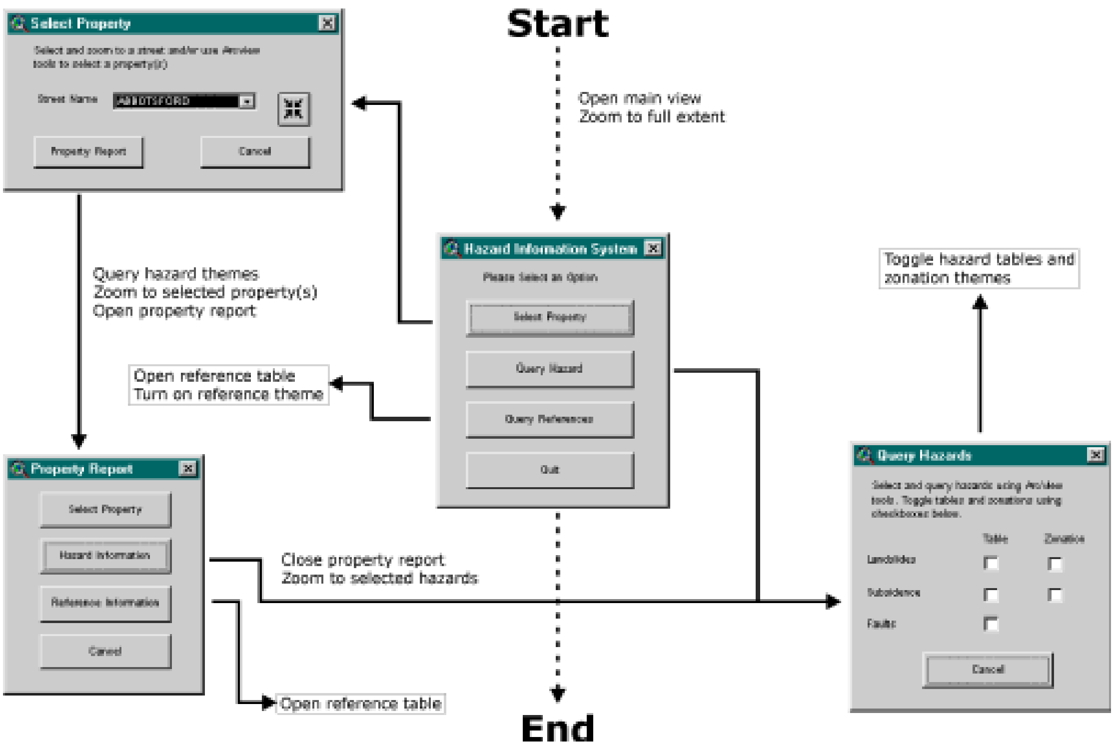

Figure 4 – Hazard Information System Menus

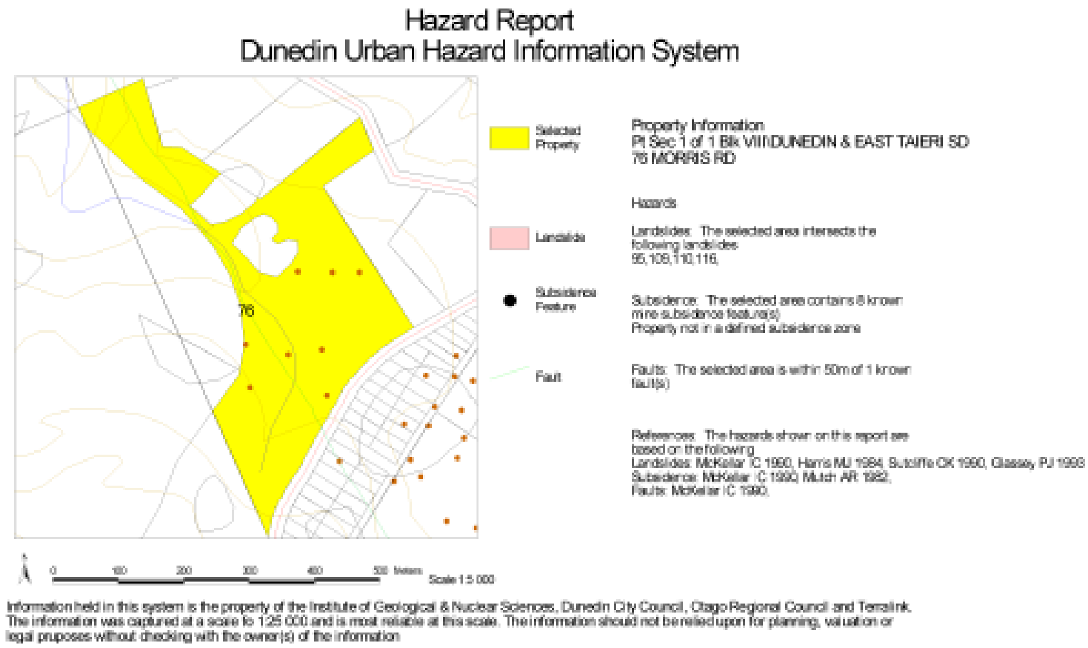

Figure 5 – Property Report

properties on the chosen street, labels them with their street number and zooms the view to them. The user can then alter the selected set using the ArcView toolbar as above.

Once a property or properties are selected a report detailing the hazards and references associated with the properties can be generated by pressing the *Property Report* button (see below and Figure 5).

Query Hazard

Selecting this button opens the *Query Hazard* dialogue box which contains several check-boxes which toggle hazard tables and zonations on and off. The ArcView toolbar can be used to select specific landslide, fault or subsidence hazard features, the attributes of which are then displayed in the appropriate table.

Query References

Selecting this button adds the reference "regions" to the view and opens the reference table. Using the ArcView toolbar references can be selected.

Quit

Exits the system.

Property Report

A property report can be generated from the *Select Property* dialogue as shown on Figure 5. It is an A4 layout which can be printed, containing a map of the selected property(s) and a list of hazards associated with the property(s). A list of the references relating to the selected hazards is also displayed. A menu is also displayed with a number of options:

Select Another Property - returns to the *Select Property* dialogue to allow user to select a different property.

Hazard Information - opens the *Query Hazards* dialogue and displays the reported hazards for the selected property(s).

Reference Information - opens a table showing further information on the references for the selected hazards.

Cancel - returns to the main menu.

5.0 Future Directions

There is no intention to develop the ArcView system further but the work has demonstrated that there is enough functionality and flexibility in graphical GIS such as ArcView to customise a query module of a Hazard Information System. The hazard layers can be supplied to interested parties such as regional and district councils to be utilised in their own customised systems. The layers could well be combined with Terralink's "TerraView" system where hazards and hazard zones can be queried for properties.

The system requires a lot of data to be collected and entered and this is possibly one of the obstacles that has hindered the adoption of the system by local authorities and others. ie. the hazard data is not available in digital form.

6.0 Conclusions

A usable and robust query module of a Hazard Information System that relates hazards to cadastral parcels via spatial overlay has been developed which can be accessed by low level GIS users in a Windows environment. Two development environments were tried and the final system was developed in ArcView using Dialog Designer and Avenue scripts.

There is enough functionality and flexibility in GIS software such as ArcView to allow those responsible for collecting, maintaining and reporting hazard information to develop a Hazard Information System to meet their requirements. However, the updating and maintenance of spatial data using ArcView is currently not possible, and the reporting of spatial graphical data and textual data is currently clumsy using ArcView.

Acknowledgements

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