

Research Initiatives in Geospatial Science at RMIT

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ABSTRACT

The Department of Geospatial Science at RMIT has developed its research programme to address discipline areas that are linked to a strategic plan. The activities are generally associated with a number of research themes: geographical visualization/multimedia cartography; geodesy and GPS; surveying; Geographical Information Science; photogrammetry and remote sensing; and environmental sustainability. Focussed research has been conducted in each of these areas and much cross-discipline research and development is also conducted.

This paper provides an overview of a research programmes undertaken in the Department, by academic and research associates, graduate students in research programmes, coursework graduate programmes and in undergraduate programmes. It then will address the issues facing research programmes at Australian Universities, and, specifically, programmes at RMIT.

Keywords and phrases: geospatial science, research

1.0 INTRODUCTION

The Department of Geospatial Science at RMIT provides academic programmes at undergraduate and graduate levels, plus a number of short courses, undertakes research in a number of strategic areas and consults with industry through its commercial arm. The synergies that have developed through the interaction between teaching, research and enterprise have resulted in innovative approaches to problem-solving that have been folded-back into the Department, which has resulted in the amalgamation of much expertise. As most educational institutions have needed to continually address what they do, and how they operate, due to the necessities of current-day tertiary government support and educational funding, this has resulted in a different *modus operandi* for many university departments. This paper provides an overview about Geospatial Science at RMIT conducts research in concert with teaching and commercial commitments.

2.0 GEOSPATIAL SCIENCE AT RMIT

2.1 RMIT

Almost 55,000 students and 3300 staff work and study at RMIT University (RMIT, 2001). It is a multi-campus university, with facilities in the City of Melbourne, at Bundoora and Brunswick. It offers programs over two levels: Higher Education and Technical And Further Education (TAFE) (formerly Vocational Education and Training (VET). The actual figures for enrolments across sectors (for 2000) were 31530 for Higher Education

and 21191 for TAFE – a total of 52721. Figure 1 illustrates the cross-sector break-up and the course load (full-time and part-time)

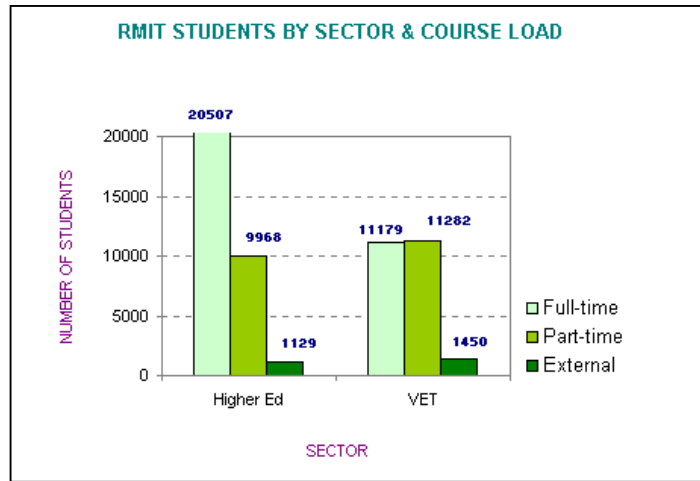


Figure 1. For the year 2000 - 52721(31530 for HE and 21191 for VET) student enrolments (Source, RMIT, 2001b).

Research student enrolments accounted for approximately 3% of the total student enrolment number– 641 full-time and 827 part-time (RMIT, 2001b). As well as research postgraduate students there also are a sizable number of students who undertake programs by coursework – 11% of RMIT’s total enrolment. Figure 2 illustrates the course enrolments by level.

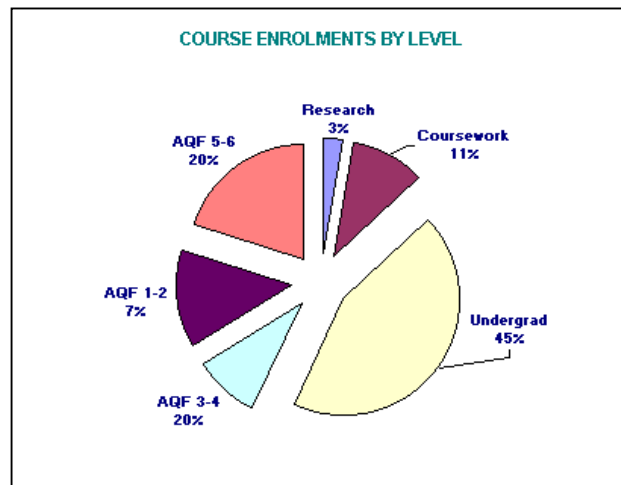


Figure 2. For the year 2000 - Research student enrolments – 641 full-time and 827 part-time (Source, RMIT, 2001b).

Geospatial Science is a member of the Faculty of Applied Science, which enrolls the second-highest number of students by Faculty. The largest Faculty (based on enrolments) is the Faculty of Business. It is worth noting that some Faculties, especially Business have a large number of ‘Offshore’ students. In 2000 the Faculty of Applied Science enrolled 2891 full-time and 827 part-time (at undergraduate and post-graduate levels).

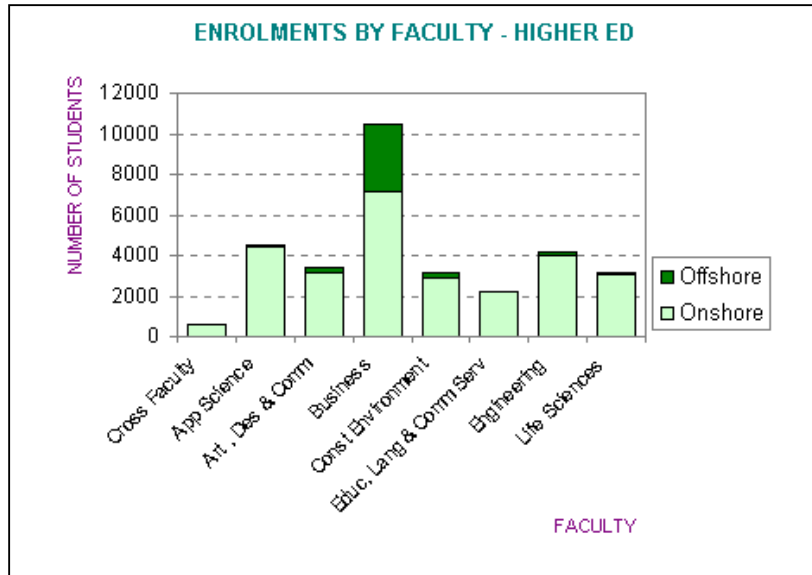


Figure 3. University enrolment – by Faculty - for the year 2000. (Source, RMIT, 2001b).

It should be noted that Universities in Australia continue to adapt to the realities of having to work with reduced funding from the Federal (Commonwealth Operating Grants). In 2000 RMIT received just 62% of its operating costs from the Government. This has necessitated a 'different' modal of operation that has acted as a catalyst for the development of University-incubated businesses like the Geospatial Science Initiative, which is briefly outlined later in the paper. Funding sources for 2000 are illustrated in Figure 4.

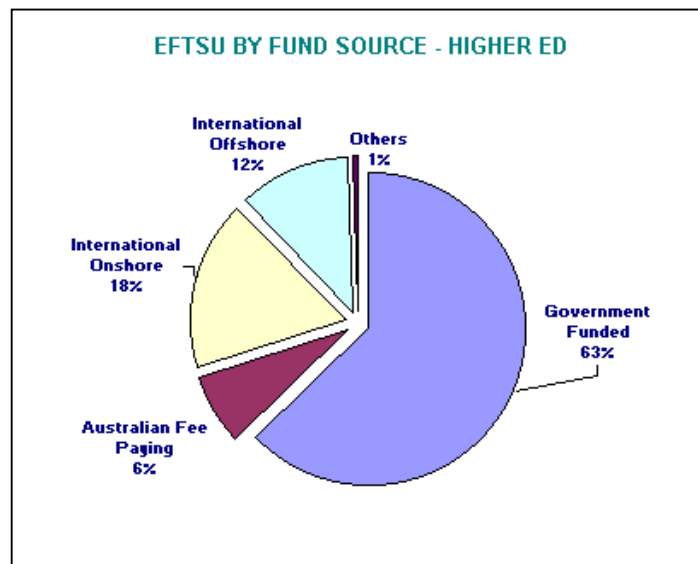


Figure 4. RMIT funding sources for 2000 (Source, RMIT, 2001b).

2.1 Geospatial Science

The Department of Geospatial Science at RMIT University is the largest academic group in Australia involved in education relating to geospatial information at the tertiary level. It is located on the City Campus, which affords excellent access to public transport and the amenities of the City of Melbourne. Developed under the guidance of the University's Strategic Plan (RMIT University, 2000), the Department developed its own strategy

plan that structured the Departmental operations into three areas: teaching and learning, research and development, and commercial enterprises.

2.1.1 Teaching and Learning

RMIT also has a Teaching and Learning Strategy (RMIT, 1998) that guides the programs offered, as well as the checks and balances required for ensuring quality programs. Undergraduate programs offered are: the Bachelor of Applied Science in Multimedia Cartography (3 years full time) plus and Honours Program in Geospatial Science (1-year full time); the Bachelor of Applied Science in Surveying (4 years full time); the Bachelor of Applied Science in Geomatics (4 years full-time); and the Bachelor of Applied Science in Geomatics/Computer Science double degree (5 years full-time). (For further information see Edwards *et al.*, 2000 and Cartwright *et al.*, 2000.).

The Department also offers two Coursework programs in GIS - a Graduate Diploma (1 year full-time 2 years part-time) and a Master of Applied Science (18 months f/t, 3-4 years p/t). The research programs are the Master of Applied Science (two years full time study or part time equivalent); and Doctor of Philosophy (Three years full time study or part time equivalent). Research degrees are offered at RMIT and also in an off-campus or external mode.

2.2.2 Research and Development

The main research foci that the Department is actively pursuing are:

- Multimedia Cartography / Geographical Visualization
- GIS
- Remote Sensing and Photogrammetry
- Surveying and GPS
- Environmental Sustainability
- Risk Analysis
- Land Administration

These research focus areas guide the development and nurturing of research programs and ensure that research activities and outcomes are 'folded into' undergraduate programs.

As well as Departmental activities there are also two research initiatives conducted with the support of the Department and the University: Contributions to the biodiversity theme of the national *State of the Environment Report* for 2001; and The Risk and Community Safety Research Initiative. Dr Jann Williams heads the team from RMIT University, ANU and the University of Melbourne who have been working on the biodiversity theme of the 2001 report. This group has produced a report on 65 environmental indicators to describe the current state of biodiversity, the pressures on biodiversity at a national scale and the response of society to conserving biodiversity. Professor John Handmer leads the Risk and Community Safety Research Initiative and it is an internationally positioned collaborative initiative undertaken by the Department, the Centre for Resource and Environmental Studies (CRES) of the Australian National University, and Emergency Management Australia through the Australian Emergency Management Institute (AEMI). The collaborative group combines internationally recognised research and research management and training expertise with the peak emergency management body in Australia. The Centre commenced in January 2001. (Risk and Community Safety Research Initiative, 2001)

2.1.3 Commercial Enterprises

The Geospatial Science Initiative (GSI) conducts commercial enterprises. It was established in March 1999 by Geospatial Science (then the Department of Land Information), with the support of the University Executive and the Faculty of Applied Science. The GSIs mission is to take a leading role in growing the geospatial science industry in Victoria and Australia. Working closely with both the University and industry partners, it aims to facilitate innovative developments in the Department's research, academic and commercial activities.

Three recent development programs are *CropWatch* – a program being developed to assist farm management, *APPRAIS* and *Mobile Location Services (MLS)*. The APPRAIS (Australian Property Risk Analysis Information System) Group conducts R&D activities related to risk associated with land use and management. Areas of current interest include propagation modelling and visualisation of land degradation (particularly associated with salinity), financial modelling of land degradation, design of salinity and agriculture monitoring systems, application of supercomputers and parallel processing, and emergency management issues. MLS (also known as

Location Based Services) seeks to exploit the Global Positioning System (GPS), the Internet, new broadband mobile telephony (including mobile network location services) and Geographic Information Systems (GIS) to develop innovative applications for business and personal use.

3.0 RESEARCH AT RMIT

The overall research activities at RMIT are coordinated by the University's Research and Development Section. Research has been organized under the 'umbrellas' of 'Virtual Research Institutes' (VRIs). This accords with the Australian Government's policy towards targeted research funding that has focused much research effort into channels of prioritised research concentrations (Commonwealth of Australia, 2000). VRIs are designed to facilitate cross-discipline and cross-sector (Higher Education and TAFE) collaboration. The current Virtual Research Institutes are:

- Information Technology;
- Social Policy and Urban & Regional development;
- Environmental Sustainability;
- Biotechnology and Drug technology;
- Globalisation and Cultural Diversity;
- Enterprise Development and Entrepreneurship; and
- Advanced Manufacturing

The research activities of the Department of Geospatial Science fall under a number of these categories.

The Research and Development Section has also sponsored research initiatives that have benefited the department through funding support for graduate student research programs. Two areas have been 'targeted' for concentrated research programs: the Gippsland Lakes, an important area for tourism, commercial and recreational fishing, agriculture and industry within Victoria; and the Hamilton region, a farming and tourist region that includes The Grampians.

Linked to the Gippsland Lakes area, the University provided 18 research scholarships for Masters and PhD students through a number of Faculties, including Applied Science (Gippsland Environmental Research Project, 2001). A number of potential graduate students in Geospatial Science were successful in obtaining scholarships that have been applied to regional environmental monitoring and auditing to support regional sustainable development in the Gippsland Lakes Ecosystem.

These projects were:

A Land (Information System) & its People: Investigating regional land management practices in terms of communities and capital, for the purposes of optimising the dissemination of information and community empowerment (Weaver - PhD).

The main project objectives are to analyse the current practices for establishing and operating regional Land Information Systems to determine if capital/resource use can be modelled and improvements in land management quantified. The developed models will then be used to predict means for empowering communities and land-custodians by optimising the use and distribution of capital available for improving natural resource management.

The management of remnant vegetation condition in the Gippsland Lakes catchment area, Victoria (Miller – PhD).

The study is located in the Gippsland Plains Grassy Woodland ecological vegetation class (EVC) within the Gippsland Lakes catchment area. The study involves the quantification and assessment of vegetation condition, the means of measuring vegetation condition, quantification of threats to vegetation condition, the means of recording vegetation condition using remote sensing applications and the means of transferring the derived information in a timely manner to and from land managers.

Dynamic simulation of regional sustainable development options focusing on land use (Rozi – PhD).

This research will demonstrate new ways to apply key computer-based natural resource information to analyse complex regional problems and identify cost-effective solutions.

New Tools to improve farm management and catchment management in regional Victoria (Coppa – PhD).

This research will develop new computer-based methods to improve on-farm management and to provide key natural resource management information to increase yields and support sustainable catchment management outcomes. A comparative study will test the new techniques in the Gippsland Lakes Ecosystem and elsewhere. This research project is directly related to the GSIs *CropWatch* program.

The Hamilton program is in its early days, but Departmental activities have begun in the area with projects related to Community GIS (through the GSI) and the application of GIS to assess tourism impacts and to facilitate planning in the Grampians. Research by academic staff member, Arrowsmith, has established a method for identifying new opportunities for sustainable nature-based tourism. The method draws upon spatial information systems technology to determine locations that exhibit optimal conditions for promoting nature-based tourism. This model enables park managers to identify locations of relative environmental resilience to probable tourism impact. The "Tourism Potential Model" is based on relative attractiveness, diversity and spatial distribution as well as biophysical environmental resilience determined from the environmental resiliency model. The model has been developed for the Grampians National Park (GNP) in western Victoria, Australia.

The Research and Development Section encourages undergraduate students to become involved in research through its Undergraduate Research Opportunities Program (UROP) (2001). It provides summer Research Scholarships that match Departmental funds (\$1146.50 per scholarship) to support such research. Projects provide students with practical research experience that may not normally be available in their degree course. Since 1997 matching funding has been provided to departments and centres conducting summer research projects. In summer 2000 the Department received support from this scheme to allow an undergraduate student to undertake preliminary data collection to facilitate a program that re-calculated the geographical centre of the State of Victoria.

The Research and Development Section also sponsors the Postgraduate Supervisor Training Program (2001) to continually improve the quality of graduate student supervision.

4.0 RESEARCH IN GEOSPATIAL SCIENCE

As noted previously, the research activities of the Department is conducted under the general headings of:

- Multimedia Cartography / Geographical Visualization
- GIS
- Remote Sensing and Photogrammetry
- Surveying and GPS
- Environmental Sustainability
- Risk Analysis
- Land Administration

This section of the paper outlines some of the research undertaken within the Department by staff, graduate students and complementary units. Note: the name at the end of each paragraph indicates the principal person conducting the research and the program, if any, with which the research is associated. Also note, some of the research initiatives have already been outlined in the section that described the RMIT Research and Development Section.

4.1 Multimedia Cartography / Geographical Visualization

The Department continues to undertake research into Multimedia Cartography. The research programmes have been implemented to explore the possibilities that multimedia offers to the mapping sciences. Research is being conducted using examples of discrete multimedia, as well as interactive multimedia cartography via the Web.

4.1.1 Telematics: New geographies and mapping techniques for visualizing these geographies

Involves researching definitions of space and place and how these definitions relate to the Internet, WWW or 'cyberspace'. Within the current era of globalisation there has been much discussion and dissemination of the shifting foundations of identity. It has been argued that there are major cultural and political changes taking place around the world that are leaving no one person unaffected. The research is questioning these arguments and addressing such issues as access, ownership and power in relation to the new virtual sites that are being

produced. Also, it is examining contemporary theoretical and practical models of cyber-geographical maps that are being published by academics and Internet Service Providers (ISPs) alike.

The history of change within the science of cartography and the cultural production of maps (primarily within western culture) forms a basis of the research. Telecommunications, transport and economics are the major catalysts for transformations occurring on a global scale, and it is these issues that are being examined most thoroughly within the project. Indeed, personal experience is the basis from which we form our opinions of the spaces and places we inhabit, so the project will also examine the role of Virtual Reality and its implications for conceptions of identity and embodiment 'outside' of physical confines. Outcomes from the research are to be used to gain and make available uncharted information on different ways that networks and webs operate, and how to actively participate within a culture of global change. (See Shaw and Cartwright, 2000)

Shaw – M App Sc

4.1.2 An investigation of an appropriate suite of techniques and technologies for the development of map products for the World Wide Web

This project is looking at what map products and Geographic Data are being displayed on the World Wide Web (Web) and what techniques are being used for the display of this data. From this it is hoped that some indication of the trends and techniques used in Geographic Data Viewing can be recognised. From this it is hoped that areas where it may be possible to combine techniques or technologies together can be found. Then investigating ways this combinations can be used to form a more user friendly or complete multimedia product for delivering map of geographic data. (See Stevenson and Cartwright, 2000 for more information)

Stevenson – M App Sc

4.1.3 The effectiveness of an Internet / intranet based three-dimensional GIS for analytical modelling and visualization of environmental / geological data

The objective of the research is investigate and develop an interactive three dimensional GIS on the Web for analytical modelling and visualization of geographic data. The application would be used as a decision making tool, enabling geographic data to be storage, manipulated, analysed, queried and modelled via the Web. GIS is an information system that models reality in a computer environment, this is reason for developing a three-dimensional GIS as opposed to the standard two-dimensional system.

Howard – M App Sc

4.1.4 Map-complementing metaphors and multimedia

This research is investigating the use of multimedia to support geographical information products. It is further developing a metaphor set that can be implemented using multimedia to complement the traditional map metaphor. The present focus of research is to evaluate whether this is an effective way of presenting geographically referenced information. (See Cartwright and Hunter, 1999)

Cartwright.

4.1.4 An evaluation of the suitability of applying the game metaphor for imparting geographical knowledge to children

This research is being conducted to test the hypothesis of the design, implementation and evaluation of a package for teaching components of geography using the genre of the Gameplayer metaphor (Cartwright, 1997). This package will, in part, consist of a spatial environment modelled upon that of early Melbourne in Australia, designed for use by students within the *SimCity 3000*® gaming software. (See Johnston and Cartwright, 2000)

Johnston – M App Sc.

4.1.4 Vic@tlas

The research programme involves the development of a contemporary atlas of Victoria as a research and development vehicle. What has been started is the investigation of the possibilities for and the methodologies involved in publishing an Interactive Atlas on the World Wide Web (Web). Locally, the last (and only) *Atlas of Victoria* (was published in 1982, there has been quite an amount of interest in the Victorian geospatial

information community to see a second edition published. As the immense cost of producing a paper atlas has disallowed such a publication being produced, the use of the Web and a distributed Geographic Information System (GIS) could be used to provide a media-rich alternative to a conventional paper atlas of the State.

At this stage of the project, it can be said that the general area of atlas production using the World Wide Web have been investigated and methodologies are being established to build and evaluate the concept. (See Cartwright, 1998; Walker *et al.*, 2000)

Cartwright, Escobar, Miller, Pupedis and Walker (PhD candidate - *Translation rules for the dynamic generation of new media atlases*)

4.1.5 Interactive multimedia mapping usability

Usability and accessibility are often the overlooked components of interactive multimedia cartography. This research is developing procedures and methodologies for application to Web-delivered geospatial information artifacts. Research results will be used to develop design guidelines for facilitating better Web mapping and geographical visualization products.

Miller

4.1.6 Mapping Cyberspace: a web discovery system for education in Victoria.

The Victorian Department of Education has recently undertaken a project to make material from approximately 200 major websites via a single entry website. The cataloguing and discovery of the resources accessed directly from the 200 sites, is to take place without intrusion to those sites. Practically, the process requires the specification of classification criteria and discovery processes that make the user's search intuitive, successful and avoid redundancy. The technology will assist users map the 'terrain' by automatically discovering and classifying resources according to the topologies developed.

This research develops a theoretical treatise on the process of mapping these 200 sites. It involves the development of mapping strategies and the definition of topologies that give meaning to mapping of the resources of the websites.

Nevile - PhD

4.1.7 Representation, presentation and interaction techniques for the provision of geospatial information via the mobile internet

The primary aims of this research are to develop representation, presentation and interaction models for the delivery of geospatial information using WAP-enabled cellular phone and mobile Internet technology and to implement these for the purposes of Australian fleet drivers. Research and testing relating to small-screen delivery of geospatial information is necessary to ensure that future products and services are usable and satisfy user needs. Expected outcomes include a greater understanding of the requirements of the Australian market, new models that will contribute to the evolution of the geospatial mobile Internet industry and a functional prototype with the potential for commercialisation. (See Cartwright and Miller, forthcoming)

4.1.8 Time geography

Professor Torsten Hägerstrand developed time Geography (TG) paradigm at The University of Lund, Sweden in the 1970s. It constitutes an ambitious proposal aimed to demonstrate and explain differences in the use of space amongst different groups of population. TG, together with Cognitive and Cultural Geography, forms part of what it has been named 'Personal Geographies'. Research has been undertaken in integrating personal geographies in GIS, combined with current GIS problems related with dealing with temporal data, have reinitiated the interest in TG. It is envisaged that a successful integration of TG and GIS will contribute to solve current time-related problems within GIS.

Escobar

4.2 GIS

4.2.1 Sensitivity analysis of 'Old Growth' forest boundaries

Bird – M App Sc

4.2.2 Developing a Web based simulated environment from GIS using VRML for tourism

This research focuses on aspects on landscape characterisation, the integration of variable data and the production of an optimum virtual environment. The project uses the Grampians National Park in the Victoria as a case study area. The case study will develop a virtual environment of the National Park from GIS using VRML to deliver it via the Web. Potential tourists for a variety of purposes, including pre-trip education, would use the virtual environment.

Counihan – M App Sc

4.2.3 Development of a Geospatial Visualisation System with Application to Soil Salinity management in Irrigation Districts

This research is developing a dynamic model which uses geo-visualization integrated with parallel processing components to monitor and simulate the area susceptible to soil salinity in the Murray Valley Irrigation Region of NSW. Groundwater information and processed remotely sensed data of irrigated land, combined with regional geology, land use and topological information, will be integrated and subsequently analysed within the model to identify the relationship between the changes in the concentration of the irrigated land and the changes in the groundwater level.

Jiang – M App Sc

4.2.4 The development of a least-cost model for the construction of utility based assets

This project used GIS to determine the lease-cost for constructing utility-based assets. It used the construction of new roads as the basis for the 'proof of concept' model.

Lane – M App Sc

4.2.5 Developing Virtual Support System to Assess Scenic Quality in Natural Landscapes

This research examines the concept of landscape attractiveness for nature-based tourism as determined by the quantification of biophysical parameters of natural landscape attractiveness. The resultant 'attractiveness appropriate map' can then be examined and modelled for potential tourism attractions in the region. It also provides recreation planners and park managers to develop diverse tourism products and facilitate sustainable tourism strategies for effective and efficient management, control and equitable distribution of visitors in space (over a large area) and time (less concentration) with acceptable minimum impacts rather than developing cumulative impacts in certain areas with low resiliency.

Chhetri – PhD

4.2.6 Data Uncertainty: Issues for the Rural Environment

This research addresses the issues associated with using digital spatial data for geographical analysis in an agricultural area. The focus is on issues relating to data uncertainty, inaccuracy, imprecision and error. The case study for the project deals with the identification of areas susceptible to soil salinity by the use of a temporal set of satellite imagery, digital topographic data and groundwater measurements from piezometers located across the study area. The limitations in the data, the difficulties associated with data integration, the need for metadata, the knowledge base requirements and the limitations associated with any output are addressed.

Fraser – PhD

4.2.7 The development of a decision support tool for rural property value determination

In rural areas, especially where agriculture is a primary source of income, land use and the condition and degradation of land is a major concern in valuation. The ability to assess a property's current worth and future worth based on the onset of saline affected areas or minimisation of these, can provide great insight to mortgage and financial institutions. Other environmental risks such as flood, drought and pest animals can also be evaluated as to their relationship if any to property value. Where finance is being sought for a farm/rural property, assessment of the risk associated with the property can prove beneficial in determining the amount that can be loaned to the client.

This research is developing a tool to provide a property value estimate and forecast values over a five-year period. A variety of data sets will be used to assist in the valuation and include individual property sales data, soil types, salinity regions, pest infestation sites, planning schemes and topographic data to name a few. A framework will be developed to assist in the integration of numerous data sets by analysis of scale, format, projection and database design problems that arise and to also minimise the loss of accuracy due to processing. Data standards and their contribution to the effectiveness and efficiency of the decision support tool developed will be assessed. This will enable sufficient information to be obtained regarding the capacity in which the tool can be used. Finally the effect data processing has on data quality will be addressed and the quality updated within the metadata. This will include an evaluation of the effect that reporting within the metadata has on the final uses of the decision support tool.

Hayles – PhD

4.2.8 A model-oriented generalization approach for improving the accuracy of natural resource databases

This research addresses the issues of the accuracy of databases used in GIS. It focuses the research on databases used in natural resources applications.

Darragh – PhD

4.2.9 Using GIS to Investigate the Invasion Biology of Bridal Creeper (*Asparagus asparagoides*)

Biological invasions have become so pervasive that they now represent a significant component of global environmental change. A significant amount of research has been undertaken in the area of invasion biology. Since the invasive process has both spatial and temporal components, it is suitable for investigation by GIS. However there are only a few recent studies that have used GIS to analyse the invasive process. Using the example of Bridal Creeper (*Asparagus asparagoides*) it is intended to model the extent of potential spread within Victoria using GIS and make predictions of changes to its distribution based on changes to land use. Bridal creeper is now being spread throughout the landscape predominantly by birds. A second objective is to investigate the phenomena of long distance seed dispersal of bridal creeper and develop a generic model of a bird spread invasive species.

Siderov – PhD

4.2.10 3D visualization and simulation of landscapes

This research is developing a number of research techniques using 3D visualization tools for the simulation of landscapes.

Zhou – PhD

4.3 Remote Sensing and Photogrammetry

4.3.1 Remote Sensing techniques for estimating chlorophyll and suspended soil concentrations in the Gippsland Lakes

The aim of this research is to develop a method that uses satellite remote sensing for the determination of quantitative parameters of optical water quality, in the Gippsland Lakes. This will assist in the long-term monitoring of the biological and nutrient status of coastal water bodies.

Apostolou – M App Sc

4.3.2 Creation of a predictive model for soil salinity in the Murray Valley irrigation region using satellite imagery, groundwater records and ancillary data.

The project involves using remote sensing to determine a correlation between irrigated land and water-table levels in the Murray Valley Irrigation region of southern New South Wales. The aim is to build a predictive model so that areas at risk from salinity both now and in the future can be determined, and appropriate management action in the allocation of water resources can take place.

Lamble – PhD

4.3.4 Soil moisture determination using radar from satellite platforms

Remote sensing techniques offer a potential solution to reliably mapping spatial soil moisture. Satellite and airborne sensors can provide spatially continuous measurements over a wide area of the earth's surface. The aim of this research is to investigate an alternative method for the determination of soil moisture based on the analysis of radar data from satellite based sensors, focusing on the area of St Arnaud in Victoria's northern Wimmera.

Morse – PhD

4.3.5 Hyperspectral remote sensing of biophysical properties of pastures for feed-base and carbon cycling applications.

The research program involves investigating and determining suitable relationships between remotely sensed hyperspectral imagery and physical data for pastures recorded on the ground at a number of research farm sites in Victoria. The aim is to facilitate improved farm management practices and planning in order to increase productivity, animal health and reduce impacts on the environment as well as providing information for input into carbon-cycling and accounting processes.

Thulin – PhD

4.3.6 Contemporary systems thinking and the development of models of technology transfer

Remote sensing is a suitable domain for the case study to develop and evaluate models of technology transfer as it encompasses a wide range of technological innovation. This includes space science, information technology and telecommunications. In the context of technology transfer in Australia, remote sensing is an interesting and relevant subject. It is typical of innovations and technologies that have been successfully developed in Australia, but have failed to provide commercial advantage due to inadequate technology transfer processes. The study consists of an action research-based investigation that uses Soft Systems Methodology to develop an organic, learning model of technology transfer. This model is then tested using highly structured interviews, which not only help to validate and extend the model, but also provide additional insight into the situation under study, and possible ways to respond to it. The outcome of this research is a meta-model for inquiry and learning that can assist in identifying suitable approaches to adopt contingent upon the particular nature of the technology and the transfer environment.

Finegan – PhD

4.3.7 - Neural networks for object recognition in digital photogrammetry

This research investigates the use of Neural Networks with digital photography and endeavours to develop new techniques for use with contemporary image analysis equipment and software. (See Bellman and Shortis, 2000)

Bellman

4.4 Surveying and GPS

4.4.1 The characterization and quantification of the effects of multipath on GPS

Measurements obtained using the Global Positioning System (GPS) are subject to a number of errors, such as satellite orbit error and atmospheric errors, which subsequently affect the positioning accuracy. Accurate and reliable positioning using the GPS is dependent on a faithful representation of these errors. The project aims to

develop models that can be used to faithfully represent GPS error sources. Given approximate error modelling the reliability and accuracy of GPS positioning can be improved.

Holden – M App Sc

4.4.2 High precision GPS positioning using timely orbit estimation

High precision orbital information is extremely important in the determination of GPS user positions. For real-time applications the availability of high quality real-time orbital information is of particular interest. The computation procedure, availability and latency for a number of GPS ephemerides are discussed. These ephemerides are the broadcast, IGS predicted, JPL ultra-rapid, IGS rapid, CODE precise, NGS precise and NIMA precise ephemerides. The performance of these ephemerides in terms of their accuracy and precision is evaluated by comparing them with the IGS final ephemeris, which is the most accurate and reliable precise ephemeris. (See Roulston, 2000)

Roulston – M App Sc

4.4.3 Scintillation detection for improved reliability of GPS results

GPS is effected by several error sources, one of which relates to the ionosphere. The magnitude of the effect varies with position, time of day, time of season, sunspot activity, frequency of the radio waves and geomagnetic activity. The aims of this project are to determine a method of detecting scintillation and reducing its impact on GPS positioning. This will be completed by determining what causes scintillation, qualifying the impact of scintillation on navigation and surveying, studying patterns of occurrence, determining methods of detection in real time and developing methods of reducing the impact.

Sebire – M App Sc

4.4.4 GPS and Geodesy

Research in Geodesy/GPS/engineering surveying, with particular emphasis in precise, real-time positioning services in the networking and information communication age. Application the satellite positioning techniques to multiple modal intelligent transportation, shipping operation in a harbour environment, mobile mapping, precision agriculture, emergency management and environmental management.

Zhang

4.4.5 GPS Measurements and Volcanic Activity

This research utilises GPS to determine movement of large landmasses during earthquakes. A number of studies have been undertaken, especially in the Philippines. (See Silcock and Beavan, 2001)

Silcock

4.4.6 Map Projections

Research on the adaptation of map projections to specific applications, especially related to the mapping and charting of Australia. Activities included determination of the Geographical Centre of Victoria and the Demographic Centre of Melbourne.

Deakin

4.5 Environmental Sustainability

4.5.1 Environmental Sustainability

Research into environmental sustainability is being conducted in a number of areas. Key issues related to ecology and how GIS can be used as a tool for environmental sustainability are being addressed in this research.

Norton

4.5.2 Biodiversity Conservation and management in Arid Australia

This research focusses specifically on the impacts on biodiversity from grazing, fire, tourism and climate within the arid regions of Australia. A comparative analysis, using GIS, on the effects on ecosystem and species diversity within two areas in the Northern Territory is to be done. The findings of this analysis may be used to assist in future management strategies for the conservation of biodiversity in the arid regions of Australia.

Cleary – M App Sc

4.5.3 Determining sustainable water usage for Victoria

This project seeks to investigate the spatial distribution of sustainable water resources in Victoria. Using the framework of sustainability, a set of criteria that describe available water resources will be developed. Geographic Information System (GIS) technology will be employed to produce maps of these sustainability criteria, and the modelling capacity of the GIS applied to derive a map, or maps, that represent the spatial distribution of water resource sustainability.

Watson – M App Sc

4.5.4 Conservation and Management of Avifauna in Semi-arid / arid Mallee Woodland Region of Australia

This project is examining and quantifying vegetation change across a region of semi-arid woodland with the purpose of understanding potential impacts of key drivers of change, mainly agricultural and pastoral activities, on avifauna at the landscape level. The conservation status and ecological requirements of avifauna and the implications for future biodiversity conservation and land management strategies will be assessed and discussed. From the above, an understanding of a group of birds' distribution, habitat(s), numbers, and minimum requirements for sustained existence can be obtained. Questions proposed include food types eaten, nesting requirements, numbers present, diversity, home range size and how anthropogenic influences like farming, fire and grazing and natural influences like rain, wildfires, and drought effect bird requirements. As relatively little is known about avifauna in arid and semi-arid ecosystems, this information could help conservation and government agencies better manage these fragile systems resulting in a higher likely-hood of survival for the respective species. The region of study is the Bookmark Biosphere Reserve and surrounding areas (located between Morgan, S.A., and Broken Hill, N.S.W.).

Baldyga – PhD

4.5.5 Biodiversity conservation at the bioregional level

This research is investigating ways to improve biodiversity conservation at the bioregional level by enhancing the effectiveness of geospatial science technologies. Key issues (including weed management, vegetation, fire, grazing and monitoring) are being addressed using the Burt Plain bioregion in the Northern Territory that focuses on target taxa, ecosystems and landscapes. The extent of fire across the bioregion is being examined and the variation in likelihood of fire with respect to vegetation communities, position (in terms of topography, precipitation, water balance). Mulga is the targeted fauna species and characterises key habitat requirements. A smaller area has been chosen to look at grove-inter-grove patterning of Mulga in more detail at the landscape level and the structure of Mulga in relation to landscape environment (topography, precipitation, temperature, radiation, water balance) and disturbance gradients (fire, grazing, weeds etc).

Pert – PhD

4.6 Risk Analysis

4.6.1 Problem oriented research on risk and community safety from a social science or policy perspective

The program will: develop appropriate policy frameworks for enhancing community capacity to take responsibility for risk and emergencies; investigate the role of small business in community resilience to disaster; and develop methods for improving the communication of warnings for rapid onset events.

Handmer

4.6.2 The potential application of information technology to community safety and risk management

The emphasis is on the use of the Internet and multimedia at the interface of communities and Internet technology. Both of these programs will commence in early 2002 and will be conducted through the Risk and Community Safety Research Initiative.

Handmer

4.7 Land Administration

4.7.1 A model for the integration of land tenure, land use and land degradation information to assist natural resource management

The research deals with natural resource management (at federal, state and local levels), land use management, land administration and land registration. The common theme will be the use of spatial land use data, and the knowledge of all property tenure attributes through the public cadastre, to enhance the management of natural resources. The research will develop a model for the structure of a land administration system, within an Australian State and similar governance context, that would allow an effective use of property tenure and land use information in formulating land management policy, and implementing regulation.

Mitchell - PhD

5.0 CONCLUSIONS

Research activities in the Geospatial Sciences at RMIT are conducted in its three main 'activities areas': teaching and learning, research and development, and commercial enterprises. Research is done through collaboration between these activities areas, within the University and without. It conducts research in the areas of Multimedia Cartography / Geographical Visualization, GIS, Remote Sensing and Photogrammetry, Surveying and GPS, Environmental Sustainability, Risk Analysis and Land Administration. Programs are supported through grants from the University's Research and Development Section and scholarships from the Geospatial Science Initiative and The Risk and Community Safety Research Initiative. Research spans both the undergraduate teaching program (with support from the Undergraduate Research Opportunities Program) and graduate research programs at Masters degree and Doctor of Philosophy level. The Department strives to conduct a vigorous and interesting research program and actively encourages partnerships with other University departments, colleagues at other universities, with research establishments, with government, volunteer organisations and with industry.

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