Land Administration, Spatial Systems and Cities – an Australian Perspective

Ian P. Williamson

Professor of Surveying and Land Information
Department of Geomatics
The University of Melbourne
Parkville, Victoria Australia 3052
Phone: 03 - 9344 4431 Fax: 9347 4128
Email: i.williamson@eng.unimelb.edu.au
URL: www.geom.unimelb.edu.au/people/ipw.html

Presented at SIRC 99 – The 11th Annual Colloquium of the Spatial Information Research Centre
University of Otago, Dunedin, New Zealand
December 13-15th 1999

ABSTRACT

The paper argues that any spatial information strategy for urban, local government or city jurisdiction is intimately linked to and influenced by the state or national land administration and cadastral systems where it is located. It is these state or national systems which usually provide the spatial infrastructure for urban information systems. Therefore to understand current trends in urban information systems, changes and trends in state and national land administration systems must also be understood. The paper addresses this topic by exploring the changing humankind-land relationship and the global drivers of sustainable development, micro-economic reform, globalisation and technology, with emphasis on Australian state spatial information systems. It draws on research being undertaken at the University of Melbourne to highlight some of the trends and issues.

Keywords and phrases**:** Spatial information management, land administration, cadastre, cadastral reform, spatial data infrastructures, GIS, WWW, IT, spatial hierarchy, urban, cities

1.0 INTRODUCTION

This paper attempts to explore the future directions for spatial information management in Australia from an urban land administration perspective. It recognises that there is an inter-dependence between the development of spatial information strategies at a local government or city level and those at a state or federal level. The paper draws on current spatial data infrastructure (SDI) and cadastral research being undertaken in the Department of Geomatics at the University of Melbourne to highlight issues and trends. This research highlights that land administration systems are a key component of the infrastructure that supports and facilitates the way society interacts with land. It is acknowledged that the views expressed in the paper are influenced by this research and the inevitable bias of the author.

As a result any spatial information management strategies at a local government or city level must take a broad view of land administration systems at a state and federal level. While this research focuses on Australia it is undertaken in a global context.

When planning future strategies for spatial information management, governments worldwide sometimes just concentrate on the technology and do not consider other influences or drivers – they do this at their peril. Importantly land, land issues and land administration are critical components of Geographic Information Systems (GIS); but all too often they are forgotten. Too many administrators and researchers unfortunately just focus on narrow technical and scientific issues. Within the land administration context, it is land which distinguishes GIS from being just the spatial component of information technology (IT).

There is no doubt that we are in the midst of a spatial information revolution which itself is a critical component of the IT revolution. How is this manifesting itself and what is its impact? In simple terms this includes the emergence of new disciplines and professions, the emergence of a new private sector and new institutional structures at all levels of government. It is resulting in new research, new scientific and professional journals and new educational programs. But most importantly it is resulting in the availability of on-line spatial data, especially about land and land parcels, which has the potential to significantly change the dynamics of civil society. This is having a dramatic impact on how cities manage themselves (see for example the WWW based systems to access data in Greene County <http://www.co.greene.oh.us/gismapserver.htm> and Mecklenburg County <http://ntgis_netvs.co.mecklenburg.nc.us/taxgis/> in the USA with examples in Australia and elsewhere starting to come on-line).

Three related perspectives are considered in understanding these developments which generally focus on land administration infrastructures. First is an appreciation of the global drivers for change in the spatial information world. Next is an analysis of the impacts on the design of the land administration systems, and particularly the cadastral component, which underpin much of the spatial information trends and developments. This in turn identifies issues and opportunities in the spatial information tools which support these trends and developments, such as spatial data infrastructures and the Internet. This hierarchy of perspectives is shown in Figure 1. This is expanded in the research framework used for SDI and cadastral research at the University of Melbourne (Figure 2).

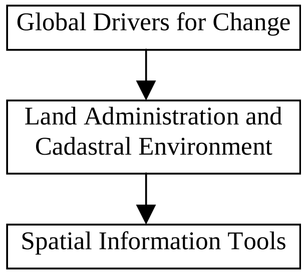

Figure 1. Hierarchy of Perspectives

This research framework attempts to describe the social system in which spatial data infrastructures and cadastral systems develop. In simple terms it recognises that society has certain needs for spatial and land related data, albeit these continually change. The model recognises there are legal, administrative, technological, innovation and diffusion processes and pressures, which influence the inevitable conceptual models which are developed to address the needs of society. The research framework also recognises that these needs, pressures and resulting models operate on a hierarchy of levels from local to global.

The paper is based around this research framework and more specifically the three perspectives of global drivers for change, land administration and cadastral trends, and spatial information tools.

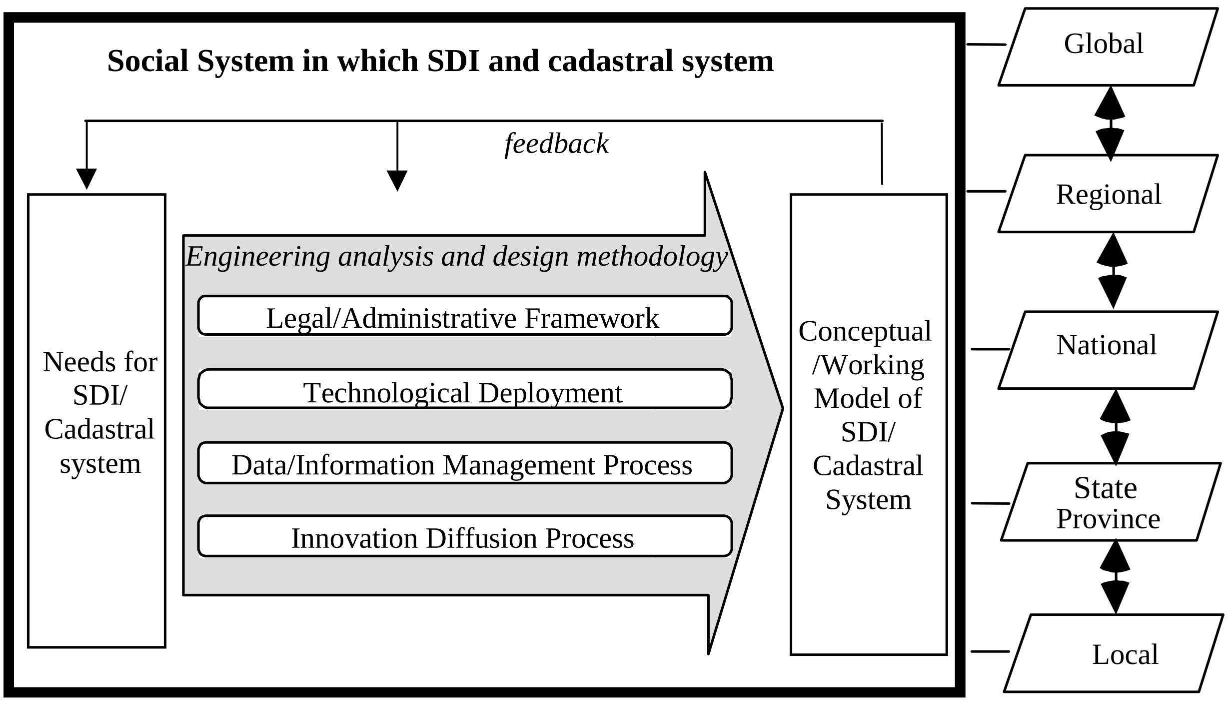

Figure 2. Research framework for Spatial Data Infrastructures and Cadastral Research

2.0 THE DRIVERS FOR CHANGE

There is no doubt that technology is a major driving force in changing the face of our spatial information world, but in many discussions and policies it is considered the only driver. In addition to technology, the major drivers of sustainable development, micro-economic reform and globalisation are discussed below.

2.1 Sustainable development

Sustainable development will be the driving force in the development of land administration policies, at all levels of government, in the decades ahead. Even though sustainable development has been the catchcry across the globe since the mid-1980s, the implementation of seminal documents such as Agenda 21 arising out of the United Nations (UN) Environment Summit and the Habitat II Global Plan of Action arising out of the UN Cities Summit, has been disappointing.

Sustainable development means development that effectively incorporates economic, social, political, conservation and resource management factors in decision-making for development – in other words for society to be able to exist and grow in sympathy with the environment in perpetuity. The challenge of balancing these competing tensions using sophisticated decision making requires access to accurate and relevant information in a readily interactive form. In delivering this objective, information technology, spatial data infrastructures, multi-purpose cadastral systems and land information business systems will play a critically important role. Unfortunately modern societies still have a long way to go before they will have these infrastructure and business systems required to support sustainable development. Understanding the land administration requirements and infrastructure to support sustainable development will be one of the major issues facing governments over the next decade.

The last three decades have been an era of growing environmental awareness. Without doubt this has dramatically influenced Australian land administration systems. The 1990s have seen the growth of importance of social issues relating to land. Evidence of this is the fall of apartheid, the fall of communism, indigenous land rights and women's access to land. Both the environmental and social drivers are key components of sustainable development.

2.2 Micro-economic reform

Micro-economic reform has had a dramatic impact on the development of spatial information management in Australia. These reforms have impacted on all levels of government and have resulted in the now common activities of downsizing, privatisation, cost recovery, performance contracts, quality assurance, and the list goes on. In the State of Victoria, an important element of the reform had been the restructuring of government departments (based on the Funder-Provider model) to sharpen their focus on core business or service delivery objectives and improve cost efficiency. This is to ensure that management decisions take account of the full costs of service delivery (Williamson *et al*.1998). Interestingly the funder-provider model is now being increasingly criticised. This trend is equally reflected at a local government level.

Another important component of micro-economic reform in Australia has been the National Competition Policy introduced by the Federal Government in 1993. All State governments agreed to implement this policy in 1995. The Victorian State Government also committed itself to the introduction of competitive neutrality principles to both government-owned businesses and predominantly tax-funded government services. The principles of competitive neutrality aim to ensure that government businesses and services do not enjoy any net competitive advantage through immunity from taxes, regulations, debt charges, and in general, full cost attribution (Williamson *et al*. 1998).

The result of all these initiatives has seen a dramatic change in the structure, mandate and operation of the government, private and academic sectors in Australian society. These changes have had a very large impact on the spatial information environment. This impact has accelerated with the increasing recognition by governments at all levels that spatial information, and more specifically appropriate spatial business systems and associated spatial data infrastructures, are essential components of any modern economy. Simply without these structures the vision of a virtual world based on electronic commerce will not be possible.

2.3 Globalisation

Within tomorrow's world, political patterns, economies and social systems worldwide are undergoing a process of profound and continuing structural change, often termed globalisation. Globalisation is becoming a reality driven by IT and communication technologies. Globalisation means the process of increasing interconnectedness between societies and jurisdictions from a social, economic and political perspective, such that events in one part of the world have increasing potential to impact on peoples and societies in other parts of the world. A globalised world is one in which political, economic, cultural and social events become more interconnected. In other words, societies are affected more and more extensively and more deeply by events of other societies. However the big challenge of globalisation is for individuals, societies and countries to fully participate in this global revolution.

Globalisation has a social, economic and political dimension. The world seems to be shrinking with people being increasingly aware of the phenomenon. The WWW is the most graphic example of this trend, since it is improving interconnectedness between and within individuals in a way never believed or dreamed possible, even a decade ago. It is a pattern of events that seems to have changed the nature of world politics from what it was just a few years ago. The important point is that the world is changing and the global village is becoming a reality. The WWW has the potential of dramatically changing the way civil society and particularly local government functions, due to the ease of access to local data.

Within this era, there is an emerging global policy, with multinational social and political movements and the beginnings of a sharing of allegiance from the local to state, national, regional and international bodies. Globalisation is a new stage in world policy that will assist in improving the quality of lives of people by thinking, working and cooperating together on common concerns.

There are many factors which encourage people to work together as part of globalisation. These factors include:

- synergy of information, technology and access, which affect each other;
- expanding global interdependence;
- increasing emphasis on sustainability; and
- increasing focus on the individual in areas such as health, personal rights, privacy, quality of life, recreation, etc.

By understanding globalisation and its social, economic and political impact on our society, we are in a much better position to develop appropriate spatial information strategies. One of the most important results is that today, more than ever before, it is important to look beyond our own local, state and national boundaries. With this in mind, many countries throughout the world believe that they can benefit from better management of their spatial information by taking a perspective that starts at a local level and proceeds through state, national and regional levels to a global level. This has resulted in the development of the Spatial Data Infrastructure concept with a hierarchical relationship between these different levels.

2.4 Technology trends

New technologies have certainly dictated changes in the development of spatial information management systems. For data capture some examples of the new technologies include satellite positioning systems such as the USA Global Positioning System (GPS), and remote sensing technologies and especially the new high resolution satellite imagery. The data base technologies that affect the storage of very large data sets have had a major impact on the spatial information revolution and especially on managing large spatial databases and data warehousing. The GIS technologies for data management, manipulation, analysis and integration arguably have had the greatest impact on the spatial information environment, although in the future the communication technologies such as the WWW and the Internet are rapidly becoming the focus of attention. These technologies are increasingly being used for viewing, locating and using spatial data. This paper however is not about describing current and future GIS technologies since they are expertly dealt with in many other forums.

3.0 THE LAND ADMINISTRATION PERSPECTIVE

The global drivers described above influence the form of land administration infrastructures which support and facilitate the way societies interact with land. These drivers influence the development of the different land administration policies and models adopted by state and national governments, which in turn influence and provide the systems on which local government and city administrations rely. These models and concepts can only be developed with a clear understanding of current land administration issues and trends. By its very nature land administration focuses on land tenure and cadastral (land parcel related) issues. The land administration perspective includes understanding the changing humankind to land relationship, cadastral issues such as national cadastral systems in countries which are a federation of states, and land tenure issues such as native title.

At the same time local government or city administrations must fully recognise these land administration trends and the impact they have on their own spatial information strategies.

3.1 The changing humankind-land relationship

One of the most important influences on the development of spatial information management is the changing relationship of humankind to land and the resulting land administration infrastructure required by these changes (Figure 3). To put this in context, it is just over 200 years ago that land markets, as we now know them, developed. This was driven by the Industrial Revolution and the growth of modern cities. In this environment land changed from being equated to wealth to being a commodity. This then saw the

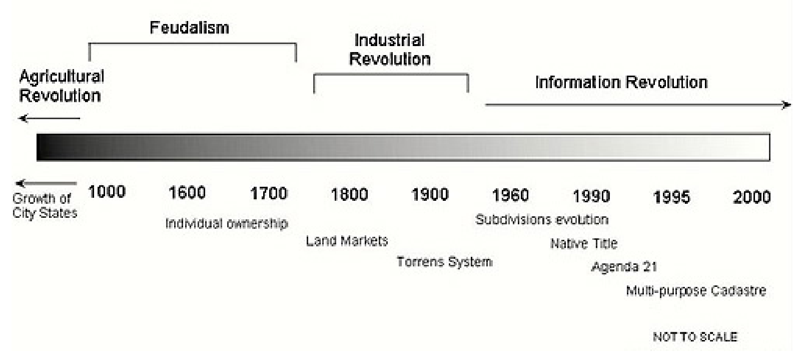

Figure 3. Sketch of evolution of western land administration systems

development of land administration systems such as the Torrens System to facilitate land markets. In simple terms the cadastre has evolved in response to these demands from society (Ting *et al*., 1999). These state or national land administration systems provide much of the infrastructure for local government and the management of cities.

In simple terms the broad development phases of the changing humankind to land relationship have been:

- Agricultural Revolution: land as wealth and cadastre as basic record and fiscal tool
- Industrial Revolution: land as commodity and cadastre as a land market tool
- Post-War: land as a scarce resource and cadastre as a planning tool
- 1980s and into the next millennium: land as a scarce community resource and cadastre as a land management tool

These changes in the relationship of humankind to land and the corresponding changes to land administrative infrastructures (Ting and Williamson 1999) are shown diagrammatically in Figure 4.

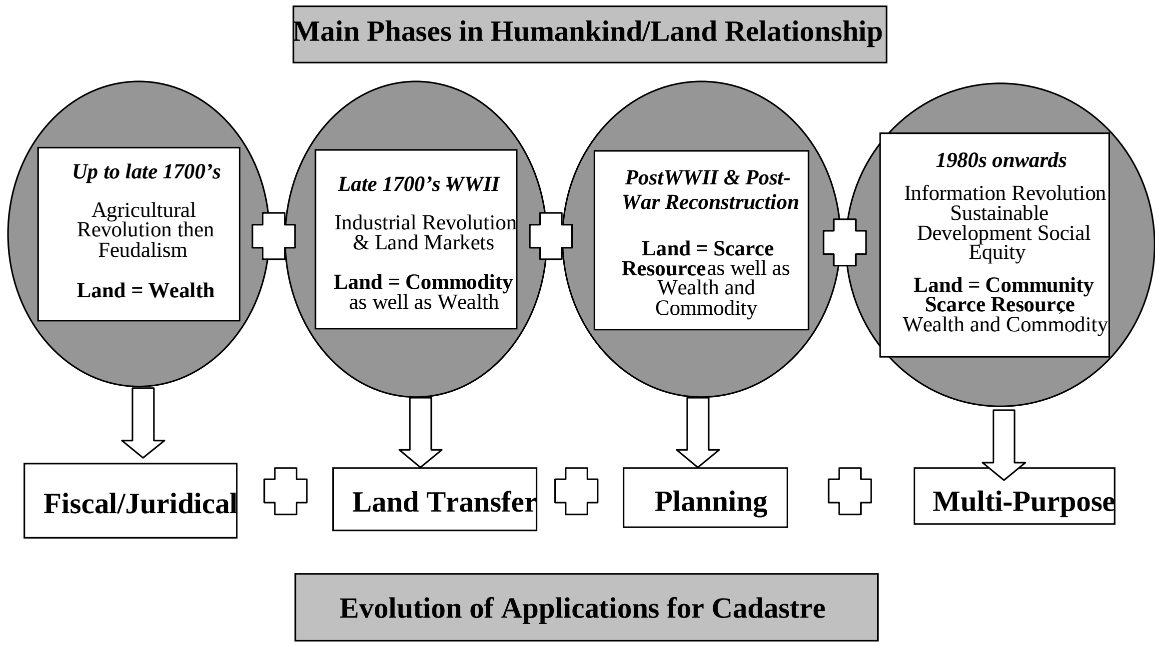

Figure 4. Evolution of the Land Administrative Infrastructure

The lesson from this research is that the relationship of humankind to land is dynamic with the resulting land administrative infrastructures also being dynamic. As a result any government at a national, state or local level which is attempting to develop future land administration or planning policies and strategies, must take this changing relationship into account. For example it is only about 30 years ago that Strata Titles were introduced and only about 15 years ago that Cluster Titles came into being.

3.2 Cadastral reform

Cadastral systems, as a critically important component of land administration systems, are continually evolving as society's attitudes and relationship to land changes. As society's relationship with land becomes more complex in terms of the ever increasing number and form of rights, responsibilities and obligations, our land administration information systems that support decision-making, primarily in support of sustainable development, must also adapt to remain relevant. The resulting cadastral reforms, which have increasingly occurred across all Australian jurisdictions over the last 20 years, give an insight to the issues and trends in both land administration and the supporting spatial information management. Following is an overview of some of the issues and trends that have formed the basis of some of the cadastral research over the last decade.

Cadastral systems can no longer rely on manual processes or traditional structures that supported economic or taxation imperatives in the past. Stand alone or isolated approaches that supported individual purposes where data and processes were maintained in separate "data silos", such as land valuation and land titling, are not sustainable. They are being replaced by multipurpose cadastral systems where information about natural resources, planning, land use, land value and land titles, including Western and indigenous interests, can be integrated for a range of business purposes. The design of modern cadastres has seen the application of contemporary system development tools such as case study methodologies and information system concepts and principles. As we move further into the information revolution, a view of what cadastres might look like in a decade or so can give a clearer view of the road ahead.

Commission 7 (Cadastre and Land Management) of the International Federation of Surveyors (FIG) has developed a vision for a future cadastral system called Cadastre 2014 (in the year 2014) (Kaufmann and Steudler 1998). Cadastre 2014 is based on international trends following extensive worldwide research over a four-year period. This document provides the first international benchmark against which cadastres can be measured in terms of development and reform. A parallel part of the process to develop Cadastre 2014 was an international benchmarking of cadastral systems around the world also undertaken by Commission 7 (Steudler *et al.*, 1997).

The creation of a digital representation of the spatial cadastre or digital cadastral data bases (DCDBs) has brought not only the benefits of digital information but also challenges in terms of how these layers are maintained and improved in terms of spatial accuracy. These DCDBs are now recognised as the most important component of a local government spatial data infrastructure. At the same time local government or city administrations are intimately linked to the maintenance and integrity of these spatial systems.

Maturity within the industry allows us to look at decentralised update mechanisms involving a number of the sources, where updates flow across the WWW. DCDBs are moving from graphical accuracy towards survey accuracy related to land use and land value, as user needs in the utility and engineering fields become more demanding. The rapid improvement in accuracy available to users of positional technology, such as with GPS and electronic distance measuring equipment, is also driving the need to upgrade the accuracy of our cadastral databases. This in turn presents many problems concerned with a "shifting cadastre" where many local government or utility assets are related to the base cadastral layer or DCDB (see Wan and Williamson 1994a, 1994b, 1995a and 1995b).

Low cost cadastres are being developed for low value lands such as Australia's semi-arid lands or rangelands. These models are increasingly moving towards multipurpose systems where data is captured by remote sensing technologies. Natural features and improvements such as roads, railways and fence lines can then be used as coordinated occupational boundaries rather than using the traditional fixed boundary approach.

Increasingly cadastres that are complete in terms of coverage and content and kept up to date will be a fundamental requirement for the development of spatial data infrastructures at both the state and national levels. The institutional arrangements for the cadastre as a component of SDIs are also being examined and in particular the role of government as a regulator of cadastral surveying. The role of regulatory boards which have operated on behalf of governments to ensure that competency standards are maintained in this regard where they underpin Torrens title and the state guarantee, is being questioned. Cadastre 2014 and current trends in Australia point towards less government intervention in this area.

4.0 THE CHANGING SPATIAL INFORMATION MANAGEMENT ENVIRONMENT

There are a range of concepts, principles and technologies that have been developed or are evolving to assist in establishing modern cadastral and land administration systems which either impact on or are equally relevant to local government or city administrations. Following are some of the issues, developments, concepts and trends which have evolved or been highlighted in the spatial information environment in recent times in Australia and have been the subject of research undertaken at the University of Melbourne. They are all characterised by being part of the increasingly rapid change in the spatial information environment and give an insight in current trends and future directions in spatial information management in Australia.

4.1 Understanding the business-infrastructure relationship in spatial information management

After studying the uptake and utilisation (diffusion) of GIS in state governments (Chan and Williamson 1996, 1999a), Chan (1998) details and validates a business-infrastructure model that can better describe how and why agencies cooperate to develop a GIS. In this model, a corporate GIS is viewed as comprising inter-related mutual-supporting multi-levelled modules of business process GIS and infrastructure GIS in the context of the business/production activities of the organisation (Figure 5).

Based on this model, an SDI is disaggregated into a collection of modules of hierarchical infrastructure GIS (the shaded ovals). The business process GIS represents the GIS capabilities developed by the *users* (the clear ovals) that rely on the SDI modules to deliver the products and services needed by the geospatial information industry. This GIS may, in turn, nurture the development of new SDI modules, and link different SDI modules together. The inherent relationships between the SDI and the business process GIS in the business-infrastructure model provide a broad framework for spatial information management.

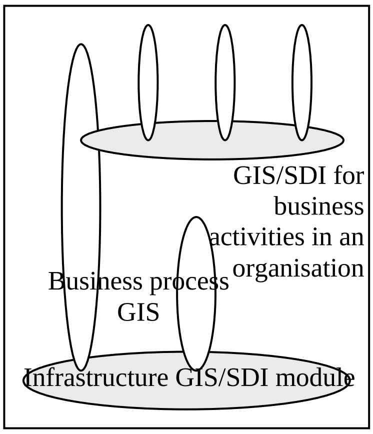

Figure 5. The business-infrastructure model.

GIS development in an organisation is driven by visions of individual business managers. Based on the support of senior management, Chan and Williamson (1999c) identify four main patterns of GIS development, namely, *opportunistic, systematic, opportunistic-infrastructure, opportunistic-business process*. The long-term success of a corporate GIS relies on a management strategy that is rigid enough to promote data/information sharing but flexible enough to accommodate the managers' visions to develop specific GIS capabilities that they need.

Based on the work of Chan and Williamson, Figure 6 describes such an approach to GIS development, which comprises three stages. GIS capabilities are developed in an *ad hoc* manner in an organisation initially and raises the corporate awareness of GIS in Stage 1. In Stage 2, senior management support enables GIS capabilities to be developed in a systematic manner, resulting in a set of standard practices laid down in a centralised corporate GIS. Within the framework of standard practices, specific GIS capabilities are allowed to be developed in business units in different patterns in Stage 3 depending on the needs of each business unit.

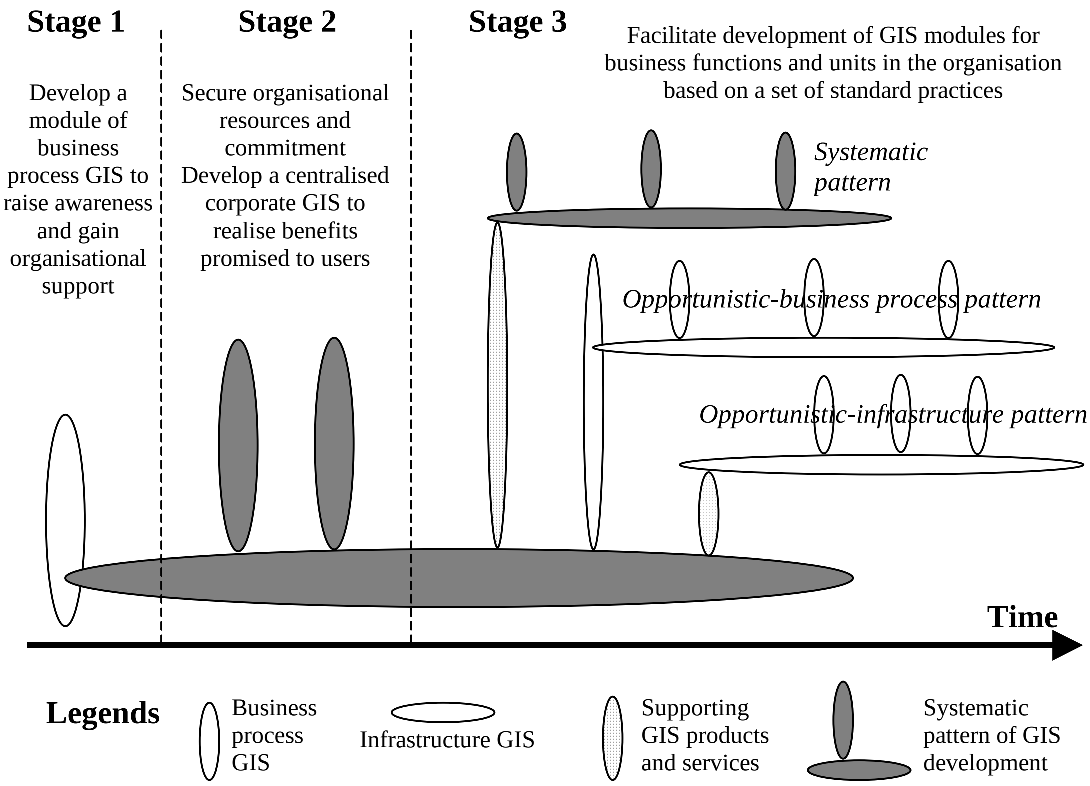

Figure 6. Three-stage development of a corporate GIS.

Fitzgerald *et al.* (1999) describe the experience of the City of Port Phillip (the Council) in Melbourne, Australia, which has adopted such a flexible approach while maintaining some elements of a structured implementation. This is achieved through developing a set of core data, standards, hardware and software in the traditional systematic manner to provide a GIS infrastructure. Flexibility is introduced by not fully specifying implementation outcomes or time frame, using *power users* to encourage ownership of the technology and a GIS working group that moulds the GIS to meet the business needs of the Council and oversees the entire process of GIS development.

4.2 Understanding the complexity of cadastral systems and the maintenance of the spatial component

A cadastral system has two components: textual and spatial. The spatial component consists of cadastral maps, the geodetic framework and survey plans. Maintenance of this spatial component involves updating and upgrading of the proposed, current legal and as built spatial data of land subdivision activities through various means including the Internet (Effenberg, *et al.* 1999, Falzon and Williamson 1998, Phillips, *et al.* 1998, Polley, *et al.* 1997) as illustrated in Figure 7. The goal of the maintenance exercise is to provide a homogeneous statewide coverage of cadastral data with minimum maintenance duplication. As shown in Figure 7, the objective is not just a matter of updating the state DCDB but of providing an updated digital environment for the effective functioning of the cadastral system.

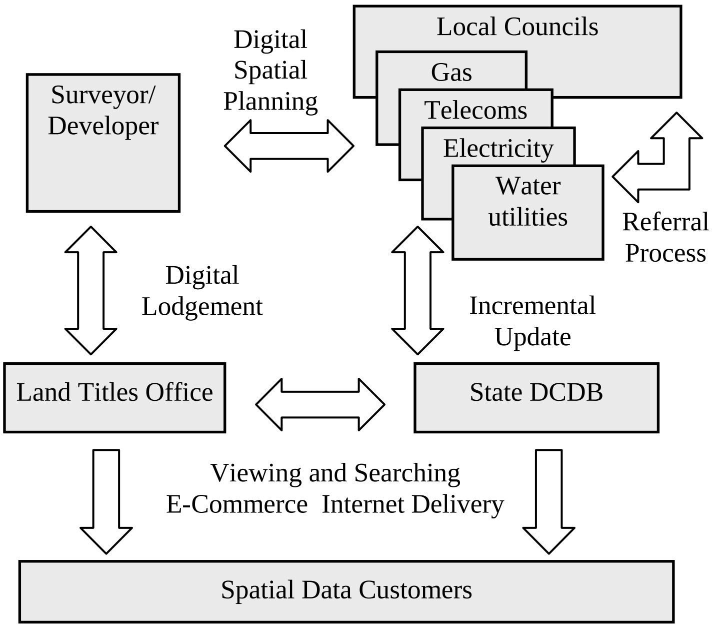

Figure 7. Complexity of Cadastral Systems

State and local governments are increasingly operating in a fully digital environment with the result that they are having to consider the complete digital environment and complexity of cadastral systems described above. On of the major issues is maintaining and improving the quality of the cadastral base which is basic infrastructure for both the state's land administration system as well as local government. States like Victoria have established a Property Information Project (PIP) where partnership arrangements have been established with all local governments in the state. The State has provided the State digital cadastral map free to councils, have agreed to maintain it free of charge and have provided funds to help establish the maintenance cycle. Councils have agreed in exchange to adopt the map base, to provide changes and updates to the State that affect the map base and to work with the State Government to improve the maintenance cycle to everyone's benefit.

Local government, utilities and state governments are increasingly recognising the benefits of digital subdivisional data and an electronic approach to update and maintenance incorporating internet and email. They have traditionally found it difficult to obtain digital survey geometry in a timely and efficient manner from its source as no standards currently exist for the handling and management of this digital survey geometry. In conjunction with all parties, there is an acceptance of the need to remotely lodge plan information in electronic form to facilitate the business of the land titles offices and to reengineer the electronic lodgment process in line with other electronic commerce.

Another important development concerns incremental updates to local government digital cadastral map (DCDB). This includes automatic integration of changed DCDB spatial data in the map base of customers with due reference to the associativity issue mentioned previously. This includes the ability of the custodian of the DCDB to source planning information at early stages to ensure maximum currency of DCDB land infrastructure eg roads and addresses. As mentioned the ability to search and deliver land information using the Internet, WWW technology and current communication technologies and practices for the delivery and purchase of products is integral to the development of the digital environment which intimately links local government to the state's land administration system.

4.3 The changing nature of spatial data infrastructures

Current spatial data infrastructures (SDIs) are in reality a sophisticated digital version of the systems that most developed nations have had for over 50 years. One important development is the recognition that SDIs comprise people, a clearinghouse/access network, technical standards, an institutional framework and framework data. The spatial data infrastructures of the past were designed and driven primarily by the providers of the infrastructure. An important change over the last decade has been the rapidly expanding numbers of users of spatial data, which are resulting in a proliferation of spatial business systems. These are increasingly

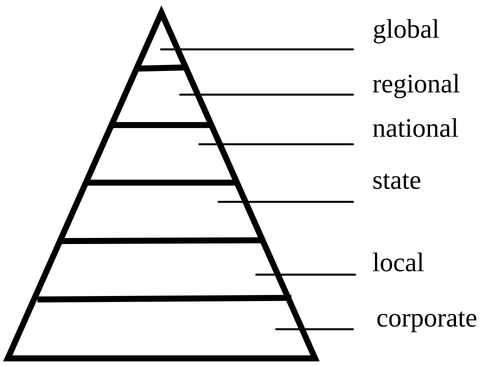

Figure 8. Hierarchy of SDIs

influencing and demanding specific characteristics from SDIs. With the rapidly changing spatial information environment and the impact of such technologies as the WWW, GPS, high resolution satellite imagery, communication technologies and sophisticated decision support systems based on GIS technologies, these spatial data infrastructures will inevitably change and develop.

In exploring such changes it is important to recognise that SDIs are increasingly being grouped into a hierarchy (Figure 8) comprising six levels of SDIs, namely, global, regional, national, state (also called provincial), local and corporate (Chan and Williamson 1999b). Ideally with compatible sets of SDIs, users working on issues at a higher level in the hierarchy can draw on data from SDIs in all other levels lower in the hierarchy (Rajabifard, *et al*. 1999).

4.4 The spatial hierarchy problem

With the advent of an increasing number of spatial business systems demanding more and more from spatial data infrastructures, problems with the "spatial hierarchy" are increasingly becoming an issue. The spatial hierarchy issue refers to the difficulties in exchanging, aggregating and analysing different data sets based on non-coterminous boundaries (Eagleson, *et al*. 1999).

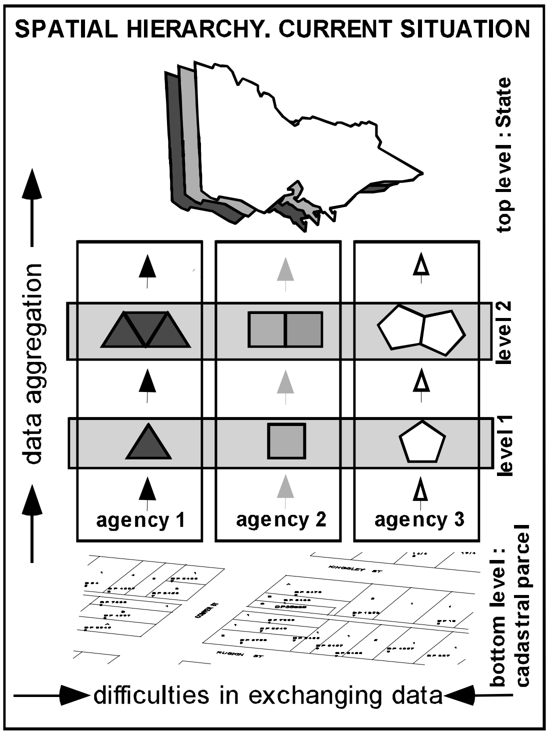

Figure 9. Current situation of managing spatial data among state agencies

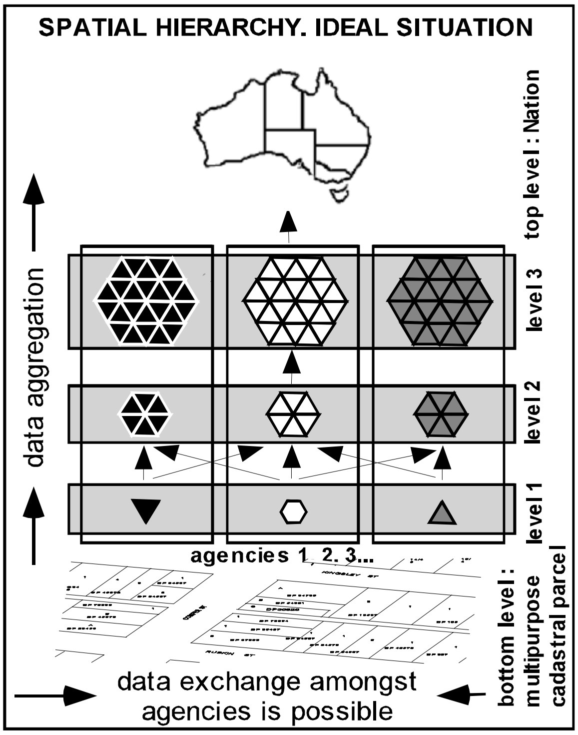

Figure 10. Ideal situation of managing spatial data among state agencies

Figure 8 illustrates the current situation where each agency collects and aggregates data based on its own hierarchically structured boundaries. The bottom layer is the land parcel map. Land parcels are recognised as indivisible units. This is common practice in most countries. As a result, data aggregation is possible within each agency but it results in great difficulties if the aim is to use data from various agencies.

Research is being undertaken to examine trends in such organisations as the Australian Bureau of Statistics (ABS), health and social security departments, and Australia Post to explore the use of Hierarchical Spatial Reasoning (HSR) in assisting in the spatial hierarchy problem. Such an approach has been applied in different applications such as way finding for navigation systems (Car, 1997). The properties inherent in HSR theory make it suitable as the base for a re-organisation of spatial units under a common hierarchy. This research aims to apply the principles of HSR theory to the re-organisation of spatial boundaries. Figure 10 shows a model where all agencies share a common structure that enables cross analysis. By applying HSR to this problem, GIS will hopefully improve its capacity for data integration (one of the items on the agenda of GIS institutions such as the National Center for Geographic Information and Analysis (NCGIA) and the University Consortium for Geographic Information Science (UCGIS)).

4.5 Developing partnerships

Partnership refers to the association of two or more people as partners in the carrying on of a business with shared risks and profits. In this context it is generally recognised that no one agency can develop a National SDI (NSDI) with the result that different national SDI coordinating agencies are encouraging NSDI development through partnerships (Federal Geographic Data Committee 1997, AUSLIG 1999). In the USA alone, over 50 major partnership initiatives have been established since 1995 on a thematic, state wide and regional basis. As mentioned previously states like Victoria have recently achieved considerable success in developing strong partnerships with local government in providing the State's SDI.

Australia has accumulated significant experience in the development of the cadastral component of its NSDI through a wide range of public-public and public-private partnerships (Mooney and Grant 1997, Williamson *et al.* 1998). Some are successful and some are not, but all are important in understanding how partnerships can be better utilised in cadastral and NSDI development. The issues include standards, cost sharing, privacy, copyright and inter-state/inter-person rivalry. However, the Australian experience also suggests that where there is a need, there is always a solution. It is expected that the determining factors in an on-going research project into partnerships in SDI development will be the type of partnership, the objective, the business driver, organisation settings of the partners and leadership by visionary managers. There is no doubt that local government will be an increasingly important partner in future spatial information systems at state and national levels.

4.6 Evolving government institutions

The spatial information industry has gone through a major re-engineering over the last 20 years and particularly the last decade. As a result of micro-economic reform, government has increasingly moved away from service delivery to directing and setting policy in the spatial information environment. This has resulted in the growth of a spatial information industry. In the past this industry was considered no more than a cottage industry but through these policies an increasing number of relatively large private sector companies are evolving. Such companies are now able to invest in research and development and can begin to have an export focus.

At the same time as governments recognise the importance of spatial information to economic development and environmental management (sustainable development), government institutions have continued to evolve. A major trend has been the amalgamation of all the land related information organisations into one department, group or unit. A good example is Land Victoria in the Government of Victoria.

There has also been an important increase in spatial information development at a national level in Australia. In the past the only organisation with the ability to provide national spatial data was the Federal Government. However as a result of its mandate the Federal Government focussed on small-scale data. With the growth of medium and large-scale digital data at a state and territory level in Australia, usually based on the cadastre, users have increasingly demanded access to this data as an aggregated product at a national level. This has seen the growth of the Public Sector Mapping Agencies, an excellent example of the partnership concept in Australia, to provide these products.

Another outcome of these changing institutions has been more partnerships between academic institutions and both government and the private sectors. With universities also having been dramatically affected by micro-economic reform policies resulting in reduced government funding, universities are increasingly providing the research and development to government, research which was previously provided in-house. This is resulting in some spatial information departments in universities relying on external funds for over 50% of their operating budget.

4.7 Impact of the WWW and communications technologies

The WWW and communication technologies are having a dramatic impact on the evolving spatial information marketplace. The use of GIS in land administration over the years, in both the natural resources and parcel based areas, has resulted in the proliferation of many large distributed spatial databases. Such spatial databases require very efficient means of data management and access tools that intelligently guide users to the data. Metadata (data about data) and metadata engines are examples of intelligent spatial access tools, areas where there is considerable research being undertaken. Metadata provides users with information about the data prior to retrieving and using the data. A Metadata engine can use the metadata for searching and retrieving datasets from across the WWW (Phillips et al, 1998). The WWW is also often viewed as storage banks where spatial information can be stored and retrieved locally by Internet users. A prototype has been developed by Polley using Java and the Computer Gateway Interface (CGI) language to facilitate a two-way flow of spatial data through the WWW (Polley, 1999).

Increasingly the WWW is seen as an alternative to delivering cadastral information by public bodies to the public. In fact some government organisations are seeing their whole delivery strategy based on the WWW. This is equally the case with local government and city administrations which are rapidly adopting the WWW for facilitating access to land related and particularly land parcel related data.

WWW servers and the emergence of Map Servers also facilitate the move towards the realisation of the multi-purpose cadastre concept described over 20 years ago and more recently in the Bogor Declaration on Cadastral Reform (UN/FIG 1996) and Cadastre 2014. However it is only now, due to the technology, that the vision is becoming a reality. Together with distributed databases, and the WWW and Map Servers, a multi-purpose cadastre is expected to allow government agencies to overlay cadastral maps, title registers, planning and other vital land resources live and interactively in order to show the complete legal situation of the land to Internet users across the world (Majid et al, 1999). In other words it is becoming increasingly possible to identify all rights, restrictions and responsibilities relating to land over the WWW. No doubt the WWW, together with advanced communication and information technologies, will continue to be one of the major drivers for the future development of spatial information management in Australia.

5.0 CONCLUSION

In attempting to overview future directions for spatial information management in Australia from an urban land administration perspective, examples have been drawn from the SDI and cadastral research. These examples have tried to highlight the complexity and inter-dependency of issues in the area of spatial information management and their multi-disciplinary nature. Most importantly they have endeavoured to show that any spatial information strategy at any level of government is an important component of that jurisdiction's wider land administration strategy. In the Australian states and territories, spatial information management is strongly influenced by land administration which is responsive to global drivers. As such any spatial information management strategy must take into account sustainable development, micro-economic reform and globalisation trends and issues, in addition to the obvious technology issues, as they affect land administration. Simply put, any spatial information strategy at a local government level must take a more integrated and broader view of the land administration environment.

A key requirement in developing appropriate spatial information management strategies is understanding the interaction between the changing humankind-land relationship, sustainable development strategies, land administration systems, spatial business systems and spatial data infrastructures, while recognising the impact of technology across all these dimensions (Figure 11). In addressing this need, spatial data infrastructures will evolve to accommodate the business needs of sophisticated decision support systems and complex multi-purpose cadastres. The increasing emphasis on business needs as distinct from infrastructure needs of spatial information will inevitably see a re-engineering of current SDIs. Local government will be a key partner in these developments.

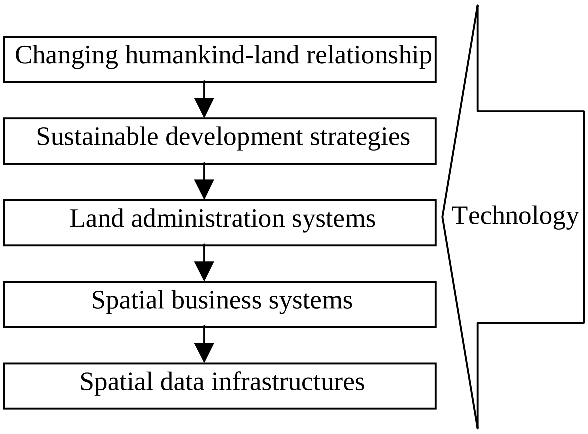

Figure 11. Developing spatial information management strategies

Sustainable development will be the focus for the changing humankind to land relationship into the next millennium. This demands sophisticated land administration infrastructures for the necessary decision-making. These in turn require support from the more generic information technologies integrated with spatial information technologies that can process and package data that is of sufficient quality, accuracy, relevance and inter-operability to the decision-maker. Herein lie the many challenges that need to be tackled in developing the next generation of spatial information systems at all levels of government.

ACKNOWLEDGEMENTS

The author gratefully acknowledges the support of Land Victoria (LV) of the Victorian Government, the Land Information Centre (LIC) of the New South Wales Government, the Australian Surveying and Land Information Group (AUSLIG) of the Commonwealth Government and the Australian Research Council (ARC) (Grants C19700324 and C49930403) in the research mentioned in the paper. The author also acknowledge the assistance provided by researcher colleagues colleagues Dr Francisco Escobar, Dr Tai On Chan, Wolfgang Effenberg, Malcolm Park, Abbas Rajabifard, Paul Harcombe, Clare Brazenor, Serryn Eagleson and Sam Majid (http://www.geom.unimelb.edu.au/research /SDI_research/) at the Department of Geomatics, the University of Melbourne in the preparation of the paper. However, the views expressed in the paper are those of the author and do not necessarily reflect the views of LV, LIC, AUSLIG or ARC.

The author acknowledges that this paper draws on three recent papers presented by the author. The first was titled "Future Directions for Spatial Information Management in Australia– A Land Administration Perspective" presented at AURISA 99 - the 27th Annual Conference of AURISA, Blue Mountains NSW, 22-26 November 1999. The second and third were by the author and Lisa Ting titled "Land administration and cadastral trends: the impact of the changing humankind-land relationship and major global drivers" and "Land administration and cadastral trends – a framework for re-engineering" and presented to the United Nations-International Federation of Surveyors International Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development in Melbourne 24-27 October, 1999.

REFERENCES

AUSLIG, (1999) Webpage on Australian Spatial Data Infrastructure Partnerships Program. Accessed 1 July 1999. <http://www.auslig.gov.au/pipc/asdi/part.htm>.

Brazenor, C., Ogleby, C.L. and Williamson, I.P. (1999) The Spatial Dimension of Aboriginal Land Tenure. To be presented at *6th South East Asian Surveyors Congress*, Fremantle, 1-6 November 1999.

Car, A., (1997) *Hierarchical Spatial Reasoning: Theoretical Consideration and its Application to Modeling Wayfinding*. PhD thesis, Technical University, Vienna.

Chan, T. O., (1998) *The Dynamics of Diffusion of Corporate GIS*. PhD thesis , The University of Melbourne.

Chan, T. O. and Williamson, I. P., (1996) A model of the decision process for GIS adoption and diffusion in a government environment. In *Proceedings of URISA '96*, (Utah: URISA) pp. 247-260.

Chan, T. O. and Williamson, I. P., (1999a) The different identities of GIS and GIS diffusion. *International Journal of Geographical Information Science*, **13**(3), 267-281.

Chan, T. O., and Williamson, I. P. (1999b) Spatial data infrastructure management: lessons from corporate GIS development. *Paper presented at AURISA 99*, Blue Mountain, NSW, 22-26 November, 10 pages.

Chan, T. O. and Williamson, I. P., (1999c), Long term management of a corporate GIS. *International Journal of Geographical Information Science*, forthcoming.

Eagleson, S., Escobar, F., and Williamson, I. P., (1999) Spatial Hierarchical Reasoning Applied to Administration Boundary Design Using GIS. To be presented at *6th South East Asian Surveyors Congress*, Fremantle, 1-6 November 1999.

Effenberg, W. W., Enemark, S. and Williamson, I. P. (1999) Framework for Discussion of Digital Spatial Data Flow within Cadastral Systems. *Australian Surveyor,* 44(1).

Falzon, K. and Williamson, I. P. (1998) Digital Lodgement of Cadastral Survey Data in Victoria. *Proceedings of the 39th Australian Surveyors Congress*, Launceston, Tasmania, 8-13 November 1998

Federal Geographic Data Committee (1997) A Strategy for the NSDI. Federal Geographic Data Committee, Reston, VA, 25 March, 1999 <http://www.fgdc.gov/nsdi/strategy/strategy.html>.

Fitzgerald, M., Dooley, P., and Chan, T. O., 1999, Just when you thought you had finished the GIS implementation. Presented at *Infrastructure '99*, (Hong Kong: 5-9 September 1999), 14 pages.

Kaufmann, J. and Steudler, D. (1998) *Cadastre 2014: A Vision for a Future Cadastral System* (Rheinfall, Switzerland: FIG).

Majid, S. I., and Williamson, I. P. (1999) Cadastral Systems on the World Wide Web: A Multi-Purpose Vision. Presented at AURISA 99, Blue Mountain, NSW, 22-26 November, 9 pages

Mooney, J. D. and Grant, D. M. (1997) The Australian Spatial Data Infrastructure. In *Framework of the World*, edited by D. Rhind. (Cambridge: GeoInformation International), pp. 187-201.

Park, M., Ting, L. and Williamson, I.P. (1998) Adverse possession of Torrens land. 72(11) Law Institute Journal 77

Park, M. and Williamson, I.P. (1999a) Australian cadastres: the role of adverse possession of part parcels. *The Australian Surveyor* (forthcoming)

Park, M. and Williamson, I.P. (1999b) The effect of adverse possession to part on a future Australian cadastre. To be presented at *6th South East Asian Surveyors Congress*, Fremantle, 1-6 November 1999.

Phillips, A., Williamson, I. P., and Ezigbalike, I. C. (1998) The Importance of Metadata Engines in Spatial Data Infrastructures. *Proceedings of AURISA '98*, Perth, Western Australia, 23-27 November 1998

Polley, I., Williamson, I. P., and Effenberg, W. W. (1997) Suitability of Internet Technologies for Access, Transmission and Updating Digital Cadastral Databases on the Web. *Proceedings of AURISA 97*, Christchurch, New Zealand, 17-21 November 1997

Polley, I. (1999) *Facilitating the use of Cadastral Data Through the World Wide Web*. MastersThesis, *University of Melbourne*, Melbourne, 124 pp.

Rajabifard, A., Chan, T. O., and Williamson, I. P. (1999) The Nature of Regional Spatial Data Infrastructures. *Paper presented at AURISA 99,* Blue Mountain, NSW, 22-26 November, 10 pages.

Steudler, D., Williamson, I.P., Kaufmann, J. and Grant D.M. (1997) Benchmarking Cadastral Systems. *The Australian Surveyor*, **42**(3), 87-106

Ting, L., Williamson, I., Grant, D. and Parker, J. R. (1999) Understanding the evolution of land administration systems in some common law countries, *Survey Review*, **35**(272), 83-102.

Ting, L. and Williamson, I.P. (1999) Cadastral Trends: A Synthesis. *The Australian Surveyor*, **44**(1), 46-54.

UN/FIG (1996) Bogor Declaration on Cadastral Reform. FIG Webpage accessed on July 30 1999. http://www.sli.unimelb.edu.au/fig7/Bogor/BogorDeclaration.html

Wan, W.Y. and Williamson, I.P. (1994a) Problems in Maintaining Associativity in LIS with Particular Reference to the Needs of the Utility Industry. The Australian Surveyor, Vol. 39, No. 3, 187-193.

Wan, W.Y. and Williamson, I.P. (1994b) Solutions to Maintaining Associativity in LIS with Particular Reference to the Needs of the Utility Industry. The Australian Surveyor, Vol. 39, No. 4, 290-297.

Wan, W.Y. and Williamson, I.P. (1995a) A Review of the Digital Cadastral Databases in Australia and New Zealand. The Australian Surveyor , Vol. 40, No. 1, 41-52.

Wan, W.Y. and Williamson, I.P. (1995b) The Users' View of Digital Cadastral Databases in Australia. The Australian Surveyor, Vol. 40, No. 1, 53-62.

Williamson, I. P., Chan, T. O., and Effenberg, W. W. (1998) Development of spatial data infrastructures - lessons learned from the Australian digital cadastral databases. *Geomatica*, **52**(2), 177-187.

NOTE: Most of the articles by Williamson and his colleagues can be found at <http://www.geom.unimelb.edu.au/research/publications/IPW_publ.html>

BIOGRAPHICAL SKETCH

Professor Ian Williamson PhD (NSW), DrHC (Olsztyn), FTSE, FISAust, FIEAust, HonFMSIAust, LS, CPEng is Professor of Surveying and Land Information and Head of the Department of Geomatics at the University of Melbourne. He teaches and undertakes research in the areas of cadastral, land and geographic information systems, land administration and spatial data infrastructures, in conjunction with his research team. He has undertaken consultancies worldwide in his area of expertise including for AusAID, the United Nations and the World Bank. He was Chairperson of Commission 7 (Cadastre and Land Management) of the International Federation of Surveyors 1994-98, and is currently Director, FIG/UN Liaison 1999-2002. At Melbourne he has been President of the Academic Board and Pro-Vice-Chancellor. He is currently Chairperson of the Victorian Government's Geospatial Information Reference Group. Professor Williamson was awarded the AURISA Eminent Individual Award in 1996 and the Medal of the Institution of Surveyors, Australia in 1997, was elected a Fellow of the Academy of Technology Sciences and Engineering and was awarded the honorary degree of Doctor Honoris Causa, Olsztyn University of Agriculture and Technology, Poland, in 1998.