Land Administration, Information Technology and Society

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Abstract

Land administration reforms into the future are likely to be influenced by:

- Society's changing priorities
- Globalization
- Information technology revolution

The latter is an important tool in delivering land information systems that support society's changing needs. However, technology also has the potential to dominate rather than serve society. The challenge will be to harness the information revolution to support land administration reform that addresses society's needs.

This paper outlines the evolution of the humankind to land relationship with a view to demonstrating the changes in society that highlight user-needs for information technology. The paper will address this issue in two parts:

First, whilst the economic imperatives have and always will drive reforms to land administration systems, western society in particular is experiencing a phenomenon of measures to formally temper those economic imperatives with concern for sustainable development, the environment and social justice.

Second, information technology has the potential to greatly assist those processes. From society's perspective, what are the existing capabilities of and concerns about this technology? How do these fit with land administration trends for the future?

***Keywords and phrases*:** land administration; humankind/land relationship; information revolution; civil society.

1.0 Introduction

Land administration is about translating the relationship between humankind and land into the formal processes of administration in society. Just as society is dynamic and its relationship with land is dynamic (Figure 1), so must land administration systems be dynamic.

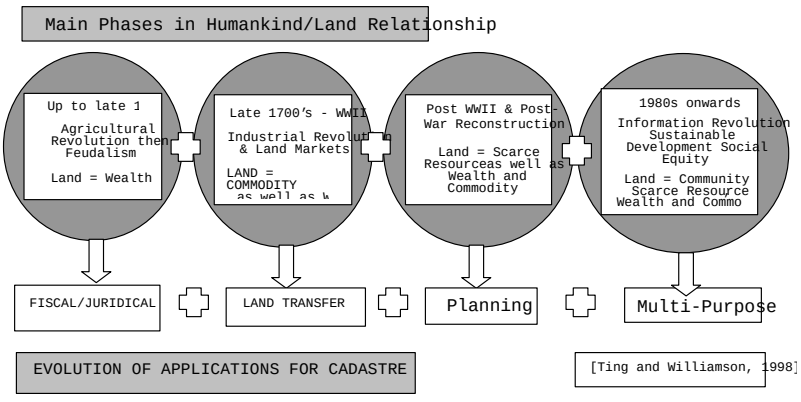

Figure 2: Main Phases in the Humankind/Land Relationship and Cadastral Evolution

"Cadastral systems are the foundation and an integral component of parcel-based land information systems (LIS) that contain a record of interests in land. These systems are a central component of the land administration and land management systems in a state or jurisdiction" [Williamson, 1990]. Yet land information systems are a relatively recent application of cadastral systems. Cadastral systems date back a long way and have evolved over thousands of years.

1.1 Land as Wealth and Cadastre as Basic Record and Fiscal Tool

In the early stages of human settlement, land was undisputedly the primary source of wealth and power [Grant, 1997]. In that context cadastre's primary function was as a record of ownership and as a fiscal tool. It is important to note that the objective of the record was to provide some security of ownership (or use) as against the world and to do so, required a record which was publicly acknowledged and respected. Historically, the need for delimitation arose as soon as anyone – a tribe, a family, or an individual – laid claim to a particular right in an area [Larsson, 1996].

The earliest records of land ownership date back to the Royal Registry of Ancient Egypt that was created in about 3000BC [Larsson, 1996]. The Romans carried out a survey in 300 AD to create a register of what lands the Romans controlled as well as a basis for fiscal records [Larsson, 1996]. The feudal system where all land was owned directly or indirectly by the king, was extended and developed by the Normans after the Conquest of England in 1066 [Ting et al., 1998*a*]. The remnants in modern-day England lie in the "freehold" and "leasehold" terminology. Power in the feudal system vested in the institutional and legal structures that were put in place by the combined interests of landholders and the sovereign, such as the Domesday Book that recorded "owners" for the purpose of extracting feudal dues [Davies and Fouracre, 1995]. Henssen considered that the philosophy behind the establishment of fiscal cadastres throughout continental Europe in the early eighteenth century was the Physiocrat movement which held that land was the basis of all wealth and therefore land tax would be the basis for raising funds to maintain society [Henssen, 1975].

Mapping was not common until 1807 when Napoleon Bonaparte established the foundations of European cadastre when he ordered the creation of maps and cadastral records. The records showed the physical location of parcels of land as well as ownership across France, arranged by parcel numbers, area, land use and land values per owner. It was this combination of registry records and maps that lay the foundations for modern-day cadastral systems.

1.2 Land as Commodity and Cadastre as Land Market Tool

The usurping of land's position as the primary source of wealth began with the industrial revolution and the rise of capital. This in turn created a further important function of the cadastre as a tool to support the growth of land markets and land transfers.

The Industrial Revolution came at a time of agricultural change as well as industrial invention. There were significant land management changes which led to improved productivity such as the enclosure movement of the 1700s across Europe. In the United Kingdom (UK) about 7,000,000 acres of land were enclosed between 1760 and 1845; these were made more productive by mixed agriculture, which included crop rotation and alternating arable/pasture use [Toynbee, 1884]. The importance of land as the source of all wealth changed in the face of the rise of capital. Land became an important source of capital and thus the emphasis moved away from the physical ownership of fixed land to the conversion of land to mobile capital. The land administration and property law system which was designed to preserve attachment to land into perpetuity, became too cumbersome and unwieldy [Ting et al., 1998*a*].

Deeds of ownership were now important not only to prove ownership so a person could remain on the land as against others, but became the cornerstone of the land market by providing some proof of ownership to engender the trust necessary for the transaction of land.

The Torrens System, which suited 19th century paradigms in a young country such as Australia with large tracts of unsurveyed and untitled land, is interesting because in a sense, it is an example of legal change responding to society's needs, then propelling further changes in the land markets and land administration, including surveying methods. Together with the government guarantee of accuracy, the cadastral and land administration system that developed based on Torrens greatly assisted the development of the land market and fulfilled colonial society's desire to rapidly settle the vastness of Australia. In short, cadastre now existed to facilitate land transfers (land markets) as well as serve the purposes of recording ownership and land taxation.

1.3 Land as Scarce Resource and Cadastre as Planning Tool

The post WWII reconstruction period and subsequent population boom saw the need for better spatial planning, particularly in urban areas. There was an increased need for land administration laws and systems to address broadacre subdivisions. Land title systems had to evolve to accommodate the desire to own a piece of property within a multi-storey building e.g. condominiums or strata subdivisions [Ting et al., 1998*b*]. To achieve this also required a cadastral system that could describe ownership of space in three dimensions.

The cadastre, as the record of land parcels and registry of ownership, became a useful tool (when teamed with large-scale maps) for urban planning and the delivery of vital services like electricity, water, sewerage and so forth in situations of increasing population density. Thus a focus on planning was added to the pre-existing applications of cadastre as a fiscal and land transfers tool.

1.4 Land as Scarce Community Resource and Cadastre as Land Management Tool

As today's society faces continuing land shortages and resource scarcity, the imperative exists to better manage and plan land use. The concern about sustainable development and the environment are evident from such international instruments as Agenda 21 and the Habitat II Agenda. There are also concerns for social equity such as indigenous and women's rights. For the purposes of this paper, the emphasis will be on sustainable development concerns.

There is a need for data that can inform policy-makers about how land can be better managed in a variety of circumstances, whether for town planning purposes or for rural agricultural development. For example, the solution to problems faced by low-value agricultural lands in New South Wales, Australia must include: sustainable land-use; comprehensive integrated datasets to allow for better decision making; simplified cost-effective operation of the cadastre; and clearly defined, easily relocatable parcel boundaries supported by an appropriate low cost cadastral survey system [Harcombe and Williamson, 1998]. Society increasingly needs multi-purpose cadastres to answer its fiscal requirements, land transfer needs as well as facilitate land management.

The achievement of a useful multi-purpose cadastre is made possible by the potential of the information revolution and the technology that has continued to evolve with it. The more difficult hurdle is the fundamental legal and institutional reforms that will facilitate the data-sharing necessary to develop, support and maintain information for a multi-purpose cadastre.

In both the Australian and European contexts, cadastral systems are now closely linked with land valuation systems. In the European context, cadastral systems were originally concerned with land valuation for taxation purposes and later were linked to land registration systems. In Australia, the reverse was usually the case although the end result, which is a close relationship between land registration and land valuation, is very similar [Williamson, 1985].

Policy-making needs to respond to this changing relationship by activating corresponding reforms of the legal and administrative infrastructures. Hernando de Soto has commented that in the developing world, the basic ability to compete in the modern market economy is hindered by the absence

or inadequacy of formal legal and administrative structures for land:

> "Third-world leaders are basically facing the same challenge that politicians of western nations dealt with some 100-200 years ago: massive informality appears when governments cannot make the law coincide with the way people live and work. The difference is that today, thanks to dramatically larger populations and the communications revolution, there has been a much speedier consolidation of informal property law" [Soto, 1993].

1.5 Trends for the Future

One of the key trends for the future is concern for the environment. This demonstrates an increasing desire on the part of society to temper short-term economic imperatives with other priorities. This shift in thinking towards longer term, sustainable economic planning is exemplified by Agenda 21, the seminal document that encapsulated the deliberations of the 1992 United Nations Conference at Rio de Janeiro and the 1997 United Nations Summit in Japan on Global Warming [Ting et al., 1998*b*]. As the World Bank stated, environmental concerns have direct relevance to business and the economy:

> "Economists have long recognised pollution to be a negative externality. Without some form of regulatory protection, the environment can become an innocent victim of bad business practices" [World Bank, 1997: 66].

Increasingly, the trend is to define environmental concerns more widely and to inject them earlier into the planning process [Ting et al., 1998*b*]. One international example is the Habitat II Agenda and Istanbul Declaration on Human Settlements (1996) at the Second United Nations Conference on Human Settlements where one of the major chapters (Chapter 5) was headed "environmentally sustainable, healthy and livable human settlements". The section on shelter delivery programs clearly states the necessity for a legal framework of land use that addresses society's need to promote efficient land markets as well as sustainable land use (at Article 77):

> "To promote efficient land markets and the environmentally sustainable use of land, governments at the appropriate level should develop a legal framework of land use aimed at balancing the need for construction with the protection of the environment, minimizing risk and diversifying uses."

An excellent example of these legislative initiatives at a national level, is New Zealand's Resource Management Act 1991 which deals primarily with environmental sustainability but also addresses some social equity issues for Maoris and recognition of their unique approaches to land use and planning.

Social equity concerns, particularly with respect to women and indigenous peoples, have been highlighted in international instruments such as the UN Social Summit 1995:

> "Commitment 4(f): Recognize and respect the right of indigenous people to maintain and develop their identity, culture and interests, support their aspirations for social justice and provide an environment that enables them to participate in the social, economic and political life of their country;
>
> Commitment 5(e): Remove the remaining restrictions on women's rights to own land, inherit property or borrow money, and ensure women's equal right to work;"

Obviously, to facilitate planning at that detailed level in diverse areas such as the environment, social equity and general cadastre, there is a necessity for a multi-purpose cadastre that provides reliable information for decision-making. It should be noted that the need for sustainable development planning occurs increasingly on a global level. Apart from the obvious environmental initiative of Agenda 21, there are other particular issues of a global nature that multi-purpose cadastres could help to address, and there is an increasing acknowledgement that cadastres have a significant role to play in planning on land as well as off-shore [Hoogsteden and Robertson, 1998]. One example of an off-shore issue is the world fisheries crisis:

> "Around 100 million people in developing countries are dependant on fisheries. They are its largest and poorest stakeholders. But their livelihoods are further under threat from the general stagnation in world catches and from the large trawlers which overfish their waters...Nine of the world's 17 fisheries are in serious decline with four depleted commercially, according to the FAO...The global catch is of less value – both in terms of money and nutrition – than it was" [PANOS, 1995].

In the same vein but closer to the traditional issues of land-use planning is the importance of land for food production. FAO research in 1995 showed that from a global perspective, there are serious inequities in the use of resources:

> "The world, as a whole, is getting steadily wealthier. By the early 1990s, about 20 percent of the world's population most of it in the developed world - received over 80 percent of the world's income, while the poorest 20 percent received only 1.4 percent. The developed countries consume 70 percent of the world's energy, 75 percent of its metals, 85 percent of its wood and 60 percent of its food" [UNFAO, 1995].

The trends towards developing multi-purpose cadastres to address planning for sustainable development issues as well as fiscal and economic imperatives is evident in a range of Western nations such as Australia [Williamson, 1996]; Canada [MacLauchlan and McLaughlin, 1998]; Denmark [Enemark, 1994]; Germany, Austria and Switzerland [Hawerk, 1995]; New Zealand [Robertson, 1996]; USA [Panel on a Multi-Purpose Cadastre, 1983 #17];

The Meeting of Officials on Land Administration (MOLA) which was established in 1996 by the UN's Economic Commission for Europe, stated that for countries in transition in Central and Eastern Europe: "privatisation of land and security of ownership is increasingly stressed as a prerequisite for a successful introduction of market economy [Onsrud, 1998]. Land reform in Eastern Europe in recent times has aimed to establish land markets by developing a coordinated national land policy, institutional and legal reform, simplifying property information systems, marketing land information held by government departments and assessing the effectiveness of farm consolidation schemes [Harris and Land, 1998].

Information technology is a central tool of multi-purpose cadastres.

2.0 The Facilitating Role of Information Technology

Information technology is aimed at collecting and accessing data. Therefore, to determine the role of information technology in the land administration area, there must be an assessment of what ends the information is required to serve.

Multi-purpose cadastral systems feed into and require spatial data. The Australian and New Zealand Land Information Council (ANZLIC) analyzed the benefits of land and geographic data across Australia and found that cadastral data comprised 25% of all spatial data produced by spatial data suppliers. The report also found a cost-benefit ratio of 4:1 for overall data usage and the benefits:

> "took the form of improved business and strategic planning, increased productivity, the development of new business opportunities, improved scheduling and coordination of investment projects, and improvements in the utilization, pricing, maintenance and disposal of fixed assets. These benefits were distributed across the broad spectrum of economic activities ranging from the operation of electricity, gas and water utilities to the development of projects involving agriculture, mining and environmental management" [ANZLIC, 1995].

The push for multi-purpose cadastres has been made possible by the availability of technologies to capture spatial data. The advancement in technologies such as the Global Positioning System (GPS), satellite imaging and total stations have all made the capture of digital spatial data a relatively quick and easy process. so there is now a vast amount of spatial data in digital form, stored by several organisations at various locations across the globe [Phillips et al.,

1998]. The Vice President of the USA said in relation to LANDSAT images: "In spite of the great need for the information, the vast majority of those images have never fired a single neuron in a single human brain. Instead, they are stored in electronic silos of data" [Gore, 1998].

The integration, and subsequent querying of spatial datasets, the locating and obtaining of datasets across a network, and the transfer of dissimilar spatial datasets across networks are all concepts that have arisen in an attempt to better utilize the spatial datasets that are in existence [Phillips et al., 1998]. Aside from the availability of data, it has been the introduction of user-friendly desktop GIS in the last few years that has stimulated interest in using GIS technology in government and industry [Lee, 1997].

Conceptually, multi-purpose cadastres have been around for over two decades. As early as 1983, the US discussed the establishment of a multi-purpose cadastre to:

> "eventually support permanent linkage mechanisms among real-property title, fiscal, and administrative records. Moreover, only where these technical components are adequately provided can the multi-purpose cadasatre eventually be expanded to a multipurpose land-data system incorporating natural resource base and land-related socioeconomic data" [Panel on a Multi-Purpose Cadastre, 1983 #17].

The following three components were considered fundamental [Panel on a Multi-Purpose Cadastre, 1983 #17]: geodetic reference framework, base map, and cadastral overlay.

Australian cadastral systems are rapidly moving to multi-purpose systems much akin to their Western European and North American counterparts, for similar reasons of increased complexity of decision making about land (land use) due to concerns about sustainable development and social equity.

2.1 Cadastre 2014

One guide for application of information technology in future land administration systems is Cadastre 2014.

Cadastre 2014 is a comprehensive Land Recording system developed by the FIG's Commission VII Working Group 7.1 (1994-1998) that can replace the traditional institutions and the justifications for it included the need to support sustainable development, deliver certainty of rights and peaceful coexistence as well as the wider economic aims of internationalization [Kaufmann and Steudler, 1998]:

> "Cadastre 2014 is a methodically arranged public inventory of data concerning all legal land objects in certain country or district, based on a survey of their boundaries. Such legal land objects are systematically identified by means of some separate designation. They are defined either by private or by public law. The outlines of the property, the identifier together with descriptive data, may show for each separate land object the nature, size, value and legal rights or restrictions associated with the land object."

Studies by Kaufman and Steudler pointed to 6 principles for Cadastre 2014 [Kaufmann and Steudler, 1998]

- Show the complete legal situation of land, including public rights and restrictions.
- Separation between 'maps' and 'registers' will be abolished.
- Cadastral mapping will be defunct; it will be replaced by modelling.
- "Paper & pencil cadastre" will be replaced by modern technology.
- Cadastre will be highly privatized with public and private sector working closely together.
- Procedures for definition of private and public land objects will be identical.

Kaufmann & Steudler also stated that the surveyor would "play the role of localizing all legal land objects" and not only with private property parcels [Kaufmann and Steudler, 1998].

2.2 Changes on the Horizon

Discussion of future trends in the humankind/land relationship will be one of the central issues to be discussed at forthcoming UN/FIG-sponsored conference "International Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development" from 27-29 October 1999 in Melbourne (for more information, refer www.sli.unimelb.edu.au/UNConf99). Other central issues will relate to guidelines for cadastral structures and systems to support land management and land administration, with a focus on legal, technical and institutional infrastructures to support sustainable development as well as address evolving land tenure systems.

3.0 Challenges Ahead

> *Technology is a many-faceted wayward creature. It is of society, yet much of its activity seems to be concerned but with itself. (Ernst Braun, 1983)*

Decisions are usually only as good as the information and tools available to analyze that information. A tool such as a multi-purpose cadastre and land information system is only as good as the data that is fed into it. That data has in turn been created for a particular purpose that may not be interoperable with other data which have in turn been created for their particular purposes. The challenge for creators of multi-purpose cadastres and land information databases can be summarized as accuracy (and currency), interoperability, access (by GIS managers and the public) and privacy. The expanded list would include: wide variety of data collection methods; the range of data accuracies; lack of suitable feature coding, identification and data exchange standards; occurrence of sporadic data coverage; differing data types; the need for temporal data; incompatibility between data sets, informality of agreements between data providers and their incompatibility, particularly between pre-existing large information systems [Williamson and Hunter, 1991]. The other key issue must be the relevance to decision-making.

Some of the newest initiatives for environmental management and sustainable development, such as Tradeable Discharge Permits for air pollution control, would need GIS as a tool incorporating spatial variable into the TDP policy cycle to increase cost efficiency gains from bringing together topographic, land use, and population data as layers of information to help determine airsheds [Robey et al., 1998]. GIS can facilitate manipulation of spatial data using the cartographic modelling capabilities, increase understanding of spatial datasets through visual display and facilitate the process of dispersion modelling [Robey et al., 1998].

Accuracy

The accuracy of a particular data source especially in relation to and including the cadastral base is an important issue in GIS. There are many different data holders who layer their information on the cadastral and/or topographical base layers which in themselves do not align properly due to accuracy problems. In Victoria, the digital cadastral database has been very popular as a base layer for other datasets and Jacoby has noted that the volume of new users of cadastral datasets is decreasing as there has been a shift towards dataset maintenance and updating [Jacoby, 1996].

As data becomes more accessible, users are beginning to want to know more about ownership data, planning data, valuation data and other data, increasingly in combinations, so that directly and indirectly demand for cadastral data will continue to grow [Polley and Williamson, 1998]. This is confirmed by Canada's experience where market demands for increasingly sophisticated GIS (Geographic Information Systems) and GIA (Geographic Information Analysis) applications appear to be the primary drivers in the value of geographic information [Michell-Viret, 1997].

Interoperability

Interoperability is defined by the Open GIS Consortium (OGC) as being the ability to:

- freely exchange all kinds of spatial information about the Earth and about objects and phenomena on, above, and below the Earth's surface; and
- cooperatively, over network, run software capable

of manipulating such information [Buehler, 1996]

There is the task of developing spatial data transfer standards that can hold all types of information from each of the individual GIS formats to ensure that no data is lost in the transfer of spatial data between incompatible GIS systems [Effenberg and Williamson, 1996]. To achieve that standard is somewhat easier than convincing the various data holders as to which standard to accept. Undoubtedly the issue is also one of how much trouble and expense some powerbrokers are willing to bear to achieve the desired standard.

Access and Privacy

This brings discussion to the issue of access to information on the one hand, and privacy on the other. Access can be discussed from two different perspectives. The first is a matter of access by GIS "managers" to the data holders' information. The more complex issue is of subsequent access by the public to the information that is essentially a collection of information about individuals and their properties.

GIS "managers" aim to access individual data sources and produce useful packages of commercial value. To do so requires establishment of meta-data standards and aggregation through sophisticated negotiation with data holders to facilitate the surrender of data. Needless to say, there must be sufficient incentives in the form of monetary or efficiency improvements, to entice data holders to part with their information.

There is also the legal issue common in freedom of information laws that require use of information only for the purpose for which it was collected. It is unlikely that the information was ever collected for the ultimate purpose of being aggregated in a potentially sensitive manner, with other data in a spatial information system. The tougher issue is access by the public – the tension lies between accessibility and privacy, as is eloquently put by Michell-Viret about the Canadian experience:

> "One of the primary challenges in managing the development of this GIS technology lies in being able to strike a balance between meeting GIA practitioners' demands for more intensive geographic information processing capability with the tolerances of Canadian society for increasingly privacy-intrusive GIA" [Michell-Viret, 1997].

For example since 1996, New Brunswick, Canada established on-line access to databases on: Property Assessment and Taxation, Parcel Index Database and Property Map Database [MacLauchlan and McLaughlin, 1998]. One of the immediate outcries was from victims of domestic violence who had taken great pains to conceal their geographic location from their abusers but were suddenly exposed and locatable at the touch of a few buttons! [McLaughlin, 1998]

Alvin Toffler has asserted that in the Third Wave or the information age, what you have is not nearly as important as what you know. Certainly one of the key tools (albeit unexpected) of the information revolution is the Internet, as Black has noted: "If it [the Internet] had been anticipated, the Internet and its requisite languages, codes and protocols would most certainly have been designed differently. The problem is that the technology was well-established before the most compelling applications had been envisioned" [Black, 1997].

Polley and Williamson conclude that cadastre, GIS and the WWW are seeking to tap into mainstream markets and the common underlying concept is a geoinformation system that has a combination of spatial and aspatial information useful in a range of contexts. They go on to note that "the bottleneck is that of the Internet" because it cannot yet provide the required functionality through browsers or by allowing use of technologies by GIS vendors to develop interfaces that run inside the ordinary WWW browser. They also cite related issues of network transfer rates and security of transmissions of proprietary data [Polley and Williamson, 1998].

What exactly is "mainstreaming"? If the Internet is meant to be the great leveler that allows "the masses"

access to information, then several difficult issues need to be dealt with first:

- "The masses" can only get involved if they can afford the equipment and the training – in the USA, which is one of the wealthiest nations in the world, about 18% of African-American and Hispanic households and up to 80% of native American households, do not have a telephone, not to mention a personal computer...lack of access is particularly acute in inner city ethnic neighbourhoods and among households headed by women ...Power is power, and information is particularly useful to those who are already powerful" [Bereano, 1995]. In its Vision 21 policy, the Victorian government has proposed a scheme called the Community Skills & Networking Project (Skills.net) that aims to ensure that "all Victorians - irrespective of geographic location, age, income, and education - have access to quality on-line information technology and the necessary training and education to enable them to use it" [Multimedia Victoria, 1998]. This is a commendable policy, but what of the developing countries that cannot afford that depth of expenditure to achieve that breadth of access in terms of hardware and training?
- Power lies not only in having access to information, but rather the ability to determine where people end up in their search for information i.e. the possibility of directing traffic through control of search engines (concentration of the media eventually happened – why not the Internet?). Already, most search engines originate in the US – who owns them?
- Power also lies in the refusal to allow access to information. The Cold War was the main instigator of massive scientific and technological research and "the main beneficiaries of the new capabilities in information production, transmission and dissemination are, not unexpectedly, those who were the main initiating agents of the Cold War era – the transnational corporations, the intelligence, military and policing agencies. Especially well-rewarded have been the big businesses with worldwide operations" [Schiller, 1994:34-35]. On the other hand, how can access be had to information regarding large corporations' operations that may be necessary to determine the impact of their operations on say, the environment?
- From the point of view of the public, what can be done to protect personal information? A submission to a federal parliamentary inquiry revealed that existing privacy laws failed to cover hundreds of government organisations, including those with access to personal information supplied on a compulsory basis and some councils had already sold ratepayer details to companies, providing an instant database of customers [Luff, 1998]. An additional concern should be of how to, in practice, trace and then regulate the dissemination of information once it has been "sold-off" and circulates through the commercial sector.

Australia's Federal Privacy Commission has drafted "National Principles for the Fair Handling of Personal Information" along the lines of the OECD Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data (1980) to help businesses self-regulate their approach to information-handling. These principles dealt with collection (only when necessary and inform individual of the purpose); use and disclosure (consistent with expectations of individual and in public interest); data quality; data security; openness (with individual about data held and purpose); access and correction (allow individuals to access and correct if their information is wrong); identifiers (limit use of identifiers that government agencies have assigned to the individual); anonymity (wherever possible, preference to be given to anonymity); transborder data flows [Commission, 1998].

Whilst these guidelines are commendable, the speed and reach of information technology, particularly the Internet, means that breaches of such guidelines can have much further-reaching (and untraceable) effects than was the case with say, the print media.

Relevance to Decision-making

The most challenging issue for GIS and GIA is relevance of the data and analysis to decision-making.

Effective decision-making is the manifestation of information power.

Sustainable development intrinsically implies a contradiction at some point between the environmental and economic priorities. To balance the two and come up with a decision requires the provision of information that can somehow measure the effects of both and allow planning decisions to be the scientific art rather than the gut reaction that passes for "the will of the people". Until then, society will be at a loss to determine what direction information technology should go apart from speeding up the process of digitizing reams of information that was gathered for some other purpose at some other point in time.

Are GIS-vendors able to determine what kind of information society really needs? Perhaps one useful example is the NZ Resource Management Act 1991. In his critique of NZ's Resource Management Act 1991, Owen McShane noted at several points in this report that it was not uncommon for the planners and Councillors to err on the side of caution in granting permits to developers and for subdivisions, to the extent of probable serious effect to economic growth [McShane, 1998]. It is fair to note that what GIS and GIA need to deliver is not just better analysis of existing database information but certainly the development of new databases and analysis techniques that firmly allow ecological economics to enter decision-making in a user-friendly way. There must be more sensitivity to society's priorities and the equity of the processes of decision making:

> "The argument of ecological economics is that environmental *limits* (or targets, standards or norms) to the economy cannot in general be set through a process of comparison of private profits and social, external costs, but rather they must be set and *are* set in practice, through a process of 'social evaluation' (how else?) after scientific-political debates" [Alier, 1997].

On issues of the environment, monetary valuation does not go far enough because "as meaningful as this may be for improving the economic database, it says less about the comprehensive value of land itself and for people...Therefore monetary valuations can register only a small part of the losses due to the consumption of natural resources...The current widespread environmental degradations are insufficiently covered by the CO_2 surcharge" [Fues, 1996].

4.0 Conclusion

Throughout history, the relationship of humankind to land has been dynamic. This dynamism has had a direct impact on the creation and evolution of cadastral systems and their various functions.

It is important to note that the process of evolution of the humankind/land relationship and the resultant changes in cadastral functions, has been cumulative. Over time, the humankind/land relationship has built up layers of complexity from wealth to commodity and then as scarce community resource. Each of these phases elicited a corresponding layer of complexity in the function of cadastral systems from a simple record of ownership and fiscal tool, to a cornerstone of land markets and then increasingly detailed land-use planning. The world is at different points (and variations) of this continuum.

There is an increasing awareness that land planning has a wider community and even global imperative. Linked to this trend is the growing vision for interoperable, multi-purpose cadastres. The information technology revolution is integral to the realization of that vision.

The information revolution has considerable potential to support society's evolving humankind/land relationship by providing information for decision-makers that will enable them to make decisions favourable to sustainable development in the context of land administration and management. At the same time, issues of civil society must be addressed in order to maximize benefit and hopefully minimize disadvantages of the information technology revolution. These include affordability of technology, equitable access to information across government, business and individuals, privacy, openness of process, responsiveness of data type/s to changing needs and dynamic analysis techniques. For example, until the development of a spatial information

database on the location of koala populations, it was much more difficult fir the Koala Foundation to influence local councils in the early stages of development planning [Tabbart, 1998].

The challenge is that the type of information available, the way it is displayed/accessed and the methods of analysis employed at all levels of land administration and management, have the potential to drive rather than serve complex decision-making. A clearer understanding of society's priorities is essential to determining what kind of information is required, the most equitable methods for displaying and searching data, and what forms of analyses will best support the new frontiers of decision-making.

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