

Using Cadastres to Support Sustainable Development¹

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ABSTRACT

An important government activity for all nation states is building and maintaining a land administration system (LAS) with the primary objective of supporting an efficient and effective land market. This usually includes cadastral surveys to identify and subdivide land, land registry systems to support simple land trading (buying, selling, mortgaging and leasing land) and land information systems to facilitate access to the relevant information, increasingly through an Internet enabled e-government environment. For most countries a cadastre is at the core of the LAS providing spatial integrity and unique land parcel identification in support of security of tenure and effective land trading. For many cadastral and land administration officials and for much of society, these are the primary, and in many cases the only roles of the cadastre and LAS. However the role, and particularly the potential of LAS and their core cadastres, have rapidly expanded over the last couple of decades and will continue to change in the future.

Cadastres provide the location or place for many activities in the built environment through the cadastral map. This in turn provides the spatial enablement of the broader land administration system. Cadastres permit geocoding of property identifiers and particularly street addresses that then facilitate spatially enablement government and wider society. While the land market function of cadastres is essential, the ability to spatially enable society is proving to be just as important as or even more important than the land market function. In particular spatial enablement allows governments to more easily deliver sustainable development (economic, environmental, social and governance dimensions), increasingly the over-arching objectives of government.

This paper describes the role that cadastres play in land administration systems and also the provision of the spatial dimension of the built environment in national spatial data infrastructures (NSDI). The paper then explores how the cadastre supports spatial enablement of government and wider society to pursue sustainable development goals. It concludes by challenging land administration officials to capitalize on the potential of LAS and cadastres to improve the achievement of these goals.

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1. INTRODUCTION

Land surveyors, lawyers and land administrators are experts in designing, building and managing cadastral systems as core components of our land administration systems (LAS). They are experienced in creating, describing and defining land parcels and associated rights. Historically, society required these skills to support an efficient and effective land market in which these rights in land are traded to promote economic development. By the mid nineteenth century, trading involved buying, selling, mortgaging and leasing of rights in land. By the mid twentieth century, land administration and cadastral officials, and associated legal and surveying professionals, assumed that they understood land markets, and that they had developed appropriate professional skills to serve the needs of those markets.

Unfortunately these professionals were involved in supporting the land trading activities, not designing them. Simply there is little documentation in the literature on how to design and build a land market or even on the development and growth of land markets (however, see Wallace and Williamson, 2006a).

It is ironic that surveyors, for example, pride themselves on working from the “whole to the part”, yet they gave little effort to designing land markets, and then designing the cadastre, a LAS, and supporting technical and administrative skills to support them. Historically, as professionals we went the other way round: we often designed LAS and then hoped that they would support efficient and effective land markets. Experience around the world shows that the results in many countries are less than satisfactory.

In general existing land administration (LA) skills are appropriate for simple land markets which focus on traditional land development and simple land trading; however land markets have evolved dramatically in the last 50 years and have become very complicated, with the major wealth creation mechanisms in the most developed countries focused on the trading of complex commodities.

While the expansion of our LAS to support the trading of complex commodities offers many opportunities for LA administrators, one particular commodity - land information and particularly its spatial dimension – has the potential to significantly change the way societies operate, and how governments and the private sector do business.

The growth of markets in complex commodities is a logical evolution of our people to land relationships, and our evolving cadastral and LAS. The changing people to land relationships, the need to pursue sustainable development and the increasing need to administer complex commodities within an ICT (information and communications technologies) enabled virtual world, offer new opportunities for our land administration systems as they increasingly play a key role in spatially enabling governments and wider society. However many challenges need to be overcome before these opportunities can be achieved. For an overview of trends in spatially enabling government and society see Rajabifard (2007), PCGIAP (2007) and OSDM (2007).

Research aimed at understanding and meeting these challenges is undertaken within the Centre for Spatial Data Infrastructures and Land Administration, Department of Geomatics,

University of Melbourne (http://www.geom.unimelb.edu.au/research/SDI_research/). The over arching focus of these projects is on spatially enabling government in support of sustainable development. The Centre's initiatives involve developing a new vision for managing land information called *iLand*. The components of the vision include:

- a collaborative whole of government approach to managing spatial information using spatial data infrastructure (SDI) principles,
- better understanding of the role that LAS plays in integrated land management (land markets, land use planning, land taxation etc),
- seamless integration of built and environmental spatial data in order to deliver sustainable development objectives,
- improved interoperability between our land information silos through e-land administration,
- more flexible technology and models to support cadastres, especially to introduce a third dimension of height, and a fourth dimension of time,
- better management of the complex issues in our expanding multi-unit developments and vertical villages,
- better management of the ever increasing restrictions and responsibilities relating to land,
- better support for the creation and trading in complex commodities, and
- incorporation of a marine dimension into both our cadastres and land administration systems.

The fundamental idea is to re-engineer LAS to support emerging needs of government, business and society to deliver more integrated and effective information, and to use this information throughout government and non-government processes by organizing technical systems in the virtual environment around place or location.

2. CADASTRES AND THEIR ROLE IN LAND ADMINISTRATION SYSTEMS

An understanding of LAS and the core cadastral component, and their evolution can help predict how they will develop.

The Importance of the Cadastre

Digital information about land is central to the policy framework of modern land administration and sustainability accounting (Williamson, Enemark and Wallace, 2006a). The cadastre, or the large scale, land parcel map related to parcel indices, is the vital information layer of an integrated land management system, and, in future, will underpin information

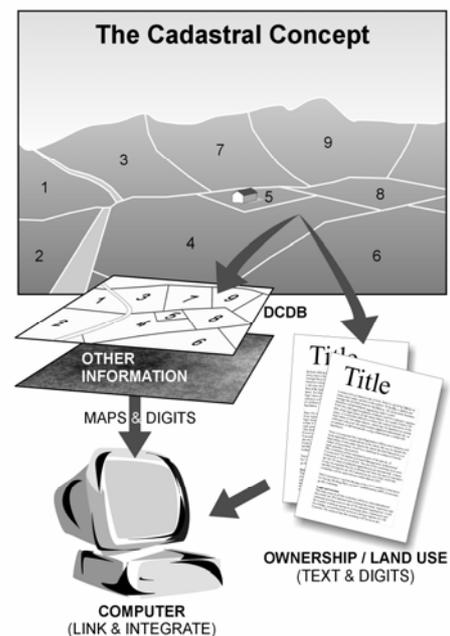


Figure 1
The Cadastral Concept
(FIG, 1995)

systems of modern governments.

While some developed countries do without a formal “cadastre”, most generate digital parcel maps (or digital cadastral data base or DCDB) reflecting land allocation patterns, uses and subdivision patterns, and even addresses and photographs. A country’s DCDB is its core information layer that reflects the use and occupation of land by society – the built environment. Critically it provides the spatial component for LAS and more particularly the location and place dimension with the most useful output being a geocoded street address of each property. Simply the cadastre is the central component in spatially enabling government. It is destined for a much broader role as fundamental government infrastructure equivalent to a major highway or railway, though it was originally created on behalf of taxpayers merely for better internal administration of taxation, and, more recently, titling of land in support of more efficient and effective land markets. Without these digital facilities, modern governments cannot understand the built environment of cities, manage land competently, utilise computer capacity to assist policy making, or retrieve significant value out of land.

The greatest potential of the DCDB lies with the information industry at large, as the principal means of translating geographic coordinates and spatial descriptors of land parcels into meaningful descriptions of places that everybody can understand. Land parcels describe the way people physically use and think about their land. The familiar configuration of parcel based descriptions in the DCDB ensures people-friendly identification of precise locations of impact of private ownership and, more vitally, of government, business and community policies, regulations and actions. In cadastres supported by professional surveyors, the descriptions have the added advantage of being legally authoritative.

While having a cadastre is not mandatory for a LAS, all modern economies recognize its importance, and either incorporate a cadastre or its key components in their LAS. For example, Australian LAS did not evolve from a traditional cadastral focus as did many of their European counterparts, but their cadastres are equal to, and sometimes improve upon, the classic European approach.

The cadastral concept shown in Figure 1 (FIG, 1995) is simple and clearly shows the textual and spatial components, which are the focus of land surveyors, land registry and cadastral officials. The cadastre provides a spatial integrity and unique identification for land parcels within LAS. However, while the cadastral concept is simple, implementation is difficult and complex. After ten years, the model still remains a useful depiction of a cadastre. However it needs to be extended to incorporate the evolving and complex rights, restrictions and responsibilities operating in a modern society concerned with delivering sustainable development as well as the social context of people to land relationships. It also does not show the important roles for the cadastre in supporting integrated land management, or in providing critically important land information to enable the creation of a virtual environment, and, at a more practical level, e-government. However, other initiatives of the International Federation of Surveyors (FIG) do highlight the changing roles of the cadastre, such as CADASTRE 2014 (FIG, 1998) and the UN-FIG Bathurst Declaration on Land Administration for Sustainable Development (FIG, 1999).

The Evolution of Land Administration Systems

The evolution of LAS is influenced by the changing people to land relationships over the centuries. Even though Figure 2 depicts a Western example of this evolving relationship, a

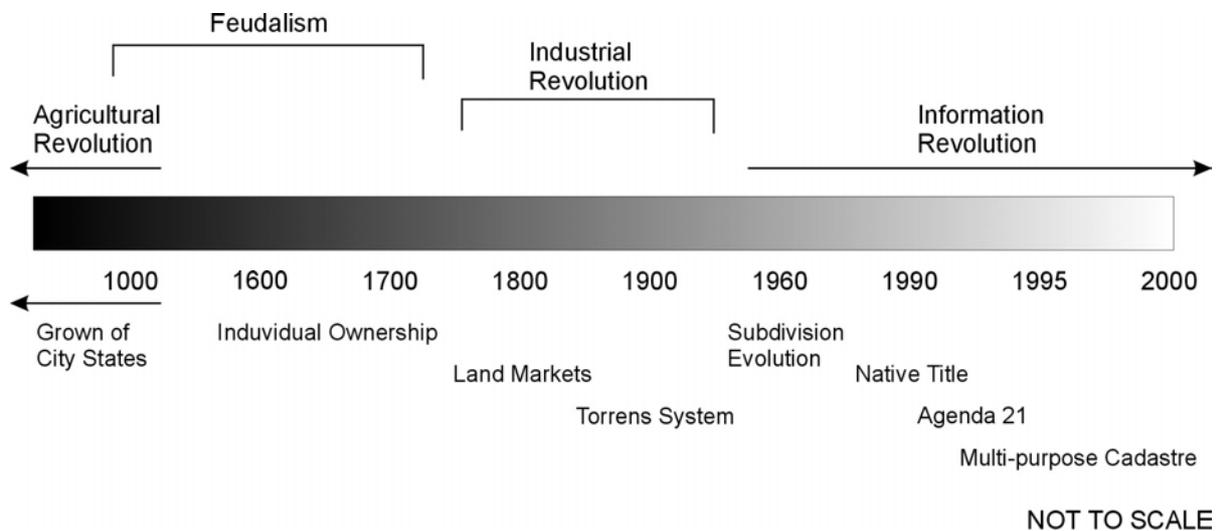


Figure 2 Evolution of people to land relationship
(Ting and others, 1999)

similar evolution can be plotted for most societies. This diagram highlights the evolution from feudal tenures, to individual ownership, the growth of land markets driven by the Industrial Revolution, the impact of a greater consciousness about managing land with land use planning being a key outcome, and, in recent times, the environmental dimension and the social dimension in land (Ting and others, 1999). Historically, an economic paradigm drove land markets; however this has now been significantly tempered by environmental and more recently social paradigms. Simply, the people to land relationships in any society are not stable, but are continually evolving.

In turn most civilisations developed a land administration or cadastral response to these evolving people to land relationships. Figure 3 depicts the evolution of these responses over the last 300 years or so in a Western context. The original focus on land taxation expanded to support land markets, then land use planning, and, over the last decade or so, to provide a multi-purpose role supporting sustainable development objectives (Ting and Williamson, 1999).

Even within this evolution, current LAS must continue to service the 19th century economic paradigm by defining simple land commodities and supporting simple trading patterns (buying, selling, leasing and mortgaging), particularly by providing a remarkably secure parcel titling system, an easy and relatively cheap land transfer system, and reliable parcel definition through attainable surveying standards.

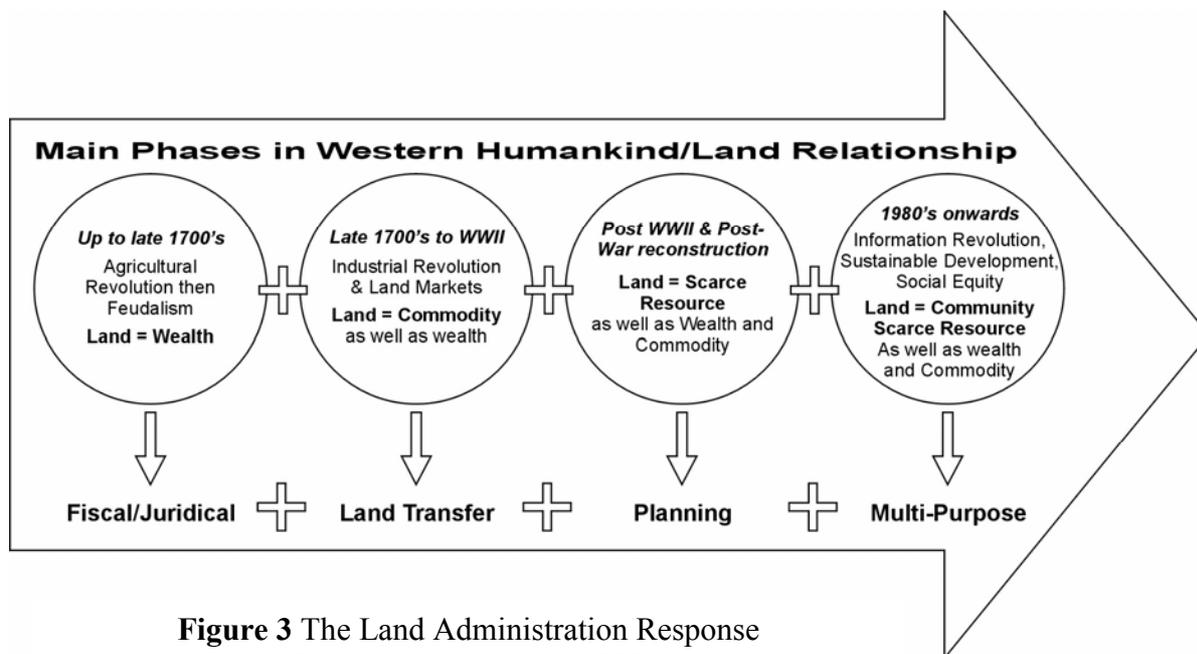


Figure 3 The Land Administration Response
(Ting and Williamson, 1999)

Arguably, Australia was a world leader in adapting its LASs to support land parcel marketing. Major innovations of the Torrens system of land registration and strata titles are copied in many other countries. However, because of the pace of change, the capacity of LAS to meet market needs has diminished. The land market of say 1940, is unrecognisable in today's modern market. After WW II, new trading opportunities and new products were invented. Vertical villages, time shares, mortgage backed certificates used in the secondary mortgage market, insurance based products (including deposit bonds), land information, property and unit trusts, and many more commodities, now offer investment and participation opportunities to millions, either directly or through investment or superannuation schemes. The controls and restrictions over land have become multi-purpose, and aim at ensuring safety standards, durable building structures, adequate service provision, business standards, social and land use planning, and sustainable development. The replication of land related systems in resource and water contexts is demanding new flexibilities in our approaches to land administration (Wallace and Williamson, 2006a).

In Australia the combination of new management styles, computerization of activities, creation of data bases containing a wealth of land information, and improved interoperability of valuation, planning, address, spatial and registration information allowed much more flexibility. However, Australian LASs remain creatures of their history of state and territory formation. They do not service national level trading and are especially inept in servicing trading in new commodities. Moreover, modern societies, which are responding to the needs of sustainable development, are now required to administer a complex system of overlapping rights, restrictions and responsibilities relating to land – our current land administration and cadastral systems do not service this need. A diagrammatic representation of the development of land administration (and cadastral) systems from a policy focus is shown in Figure 4. Unfortunately many Australian LAS still do not appreciate the central role they play in spatially enabling government and as such are not achieving their full potential.

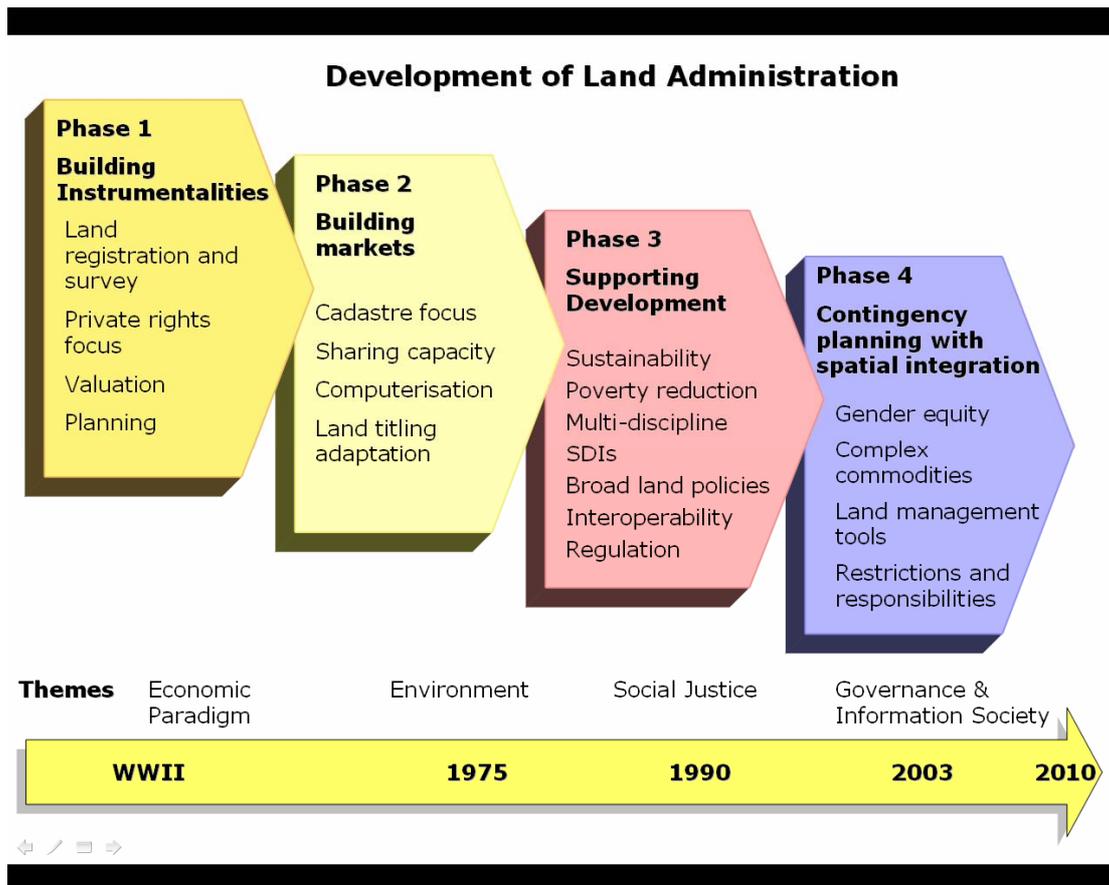


Figure 4 Development of Land Administration (after Wallace and Williamson, 2005)

The Formalization of Tenures

Modern societies are also now realising that many rights, restrictions and responsibilities relating to land exist without formalisation by governments for various policy or political reasons. This does not mean these rights, restrictions and responsibilities do not exist, but that they have not been formalized in recognizable land administration or equivalent frameworks. A good example is the recognition of indigenous aboriginal rights in land in Australia in the 1980s. Prior to the Mabo and Wik High Court decisions and the resulting legislation in Australia, indigenous rights did not formally exist. Their existence was informal but strongly evidenced by song

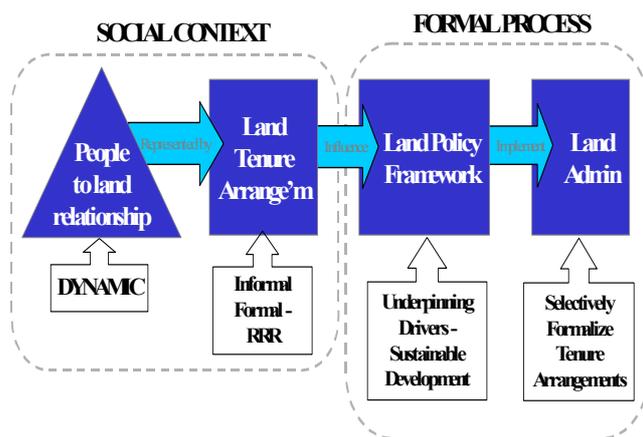


Figure 5 Formalisation of tenures (Dalrymple, Wallace and Williamson, 2004)

lines, cultural norms and other indigenous systems, a situation still familiar in the developing world where indigenous titles await more formal construction.

The process of formalising tenure and rights, restrictions and responsibilities in land is depicted in Figure 5 (Dalrymple and others, 2004 and 2005; Dalrymple, 2006). An understanding of both formal and informal rights is important as we move to develop land administration and cadastral systems that are sensitive to sustainable development objectives. Additionally, we need to recognize that change management processes and adaptation of formal systems always lag behind reality: all mature systems will simultaneously sustain both informal and highly formalized rights because the systems are not yet ready for emerging interests. Frequently, some rights will be deliberately held in informal systems: one of the largest and most significant management tools in Australia, the trust, remains beyond the land administration infrastructure and involves utilization of paperwork generated by lawyers and accountants and held in their filing drawers.

Other rights involve minimal formalization for different reasons. Residential leases, too common and too short term to warrant much administrative action, are traditionally organized outside LAS. These land rent-based distribution systems nevertheless remain potentially within the purview of modern LAS, policy makers and administrators, as illustrated by Australia's development of a geo-referenced national address file (GNAF) produced by PSMA Australia (PSMA, 2007). Indeed the development of spatial, as distinct from survey, information provides the timeliest reminder that information about land is potentially one of the most remarkable commodities in the modern land market. Certainly this commodity of information is of core interest to LA administrators.

Implementing and Understanding Regulations and Restrictions

While many rights, restrictions and responsibilities in land have not been formalized, many are established by statute or regulation but are not recorded in land registries, or any other form of register. Land uses over time must be managed to mitigate long term deleterious impacts and support sustainable development.

As an example, Australian problems of erosion, salinity and acidity are well documented. Over time, attempts to manage these shared impacts by regulating tree clearance, water access, chemical use, building standards, and more, led to very great increases in the number of laws, regulations and standards applying to land based activities. The lack of coherent management of restrictions and the information they generate is now apparent.

The problem of increasing complexity of social and environmental restrictions over land is now straining our systems, and in some cases failing. For example, the State of Victoria, Australia now has over 600 pieces of legislation that relate to land, and the national Australian Government has a similar amount. Most of these are administered outside our land administration systems. This is a world wide experience. Calls for inclusion of restrictions on land in traditionally organised LAS are common and international.

The idea of including "all restrictions in the land register" was a first-grab solution that is now recognized as impractical. Society needs a more transparent and consistent approach in

dealing with these restrictions. While modern registries are adapting to manage those restrictions compatible with their traditional functions, spatial enablement of governments and businesses offer different solutions (Bennett and others, 2005, 2008a and 2008b). The management of these many rights, restrictions and responsibilities (RRR) has introduced the concept of adding RRR either “above or below” the land register. That is if it is “above the register”, it is included on the register with all the government guarantees and controls that are associated with registered interests. If it is “below the register” the RRR are not included on the register but use the integrity of the register or information flowing from the register such as a geocoded street address to reference the information.

The Changing Nature of Ownership

The rapid growth of restrictions on land in modern societies is paralleled by a change in the nature of land ownership. Nations are building genuine partnerships between communities and land owners, so that environmental and business controls are more mutual endeavors. Rather than approach controls as restrictions, the nature of ownership is redesigned to define opportunities of owners within a framework of responsible land uses for delivery of environmental and other gains. This stewardship concept is familiar to many Europeans long used to the historical, social and environmental importance of land. For these Europeans, the social responsibilities of land owners have a much longer heritage, with the exemplar provision in the German Constitution insisting on the land owner’s social role. The nature of land use in The Netherlands, given much of the land mass is below sea level, presupposes high levels of community cooperation, and integrates land ownership responsibilities into the broader common good. The long history of rural villages in Denmark and public support for the Danes who live in rural areas also encourages collaboration. (Williamson and others, 2006b)

The Australian mining industry provides typical examples of collaborative engagement of local people, aboriginal owners and the broader public. The Australian National Water Initiative and the National Land and Water Resources Audit reinforce the realisation that activities of one land owner affect others. The development of market based instruments (MBI), such as EcoTenders and BushTenders, is an Australian attempt to build environmental consequences into land management. Australia’s initiatives in “unbundling” of land to create separate, tradable commodities, including water titles, are now established and are built into existing land administration systems as far as possible. As yet a comprehensive analysis of the impact of unbundling land interests on property theory and comprehensive land management is not available.

Whatever the mechanism, modern land ownership has taken on social and environmental consequences, at odds with the idea of an absolute property owner. Australia and European approaches to land management are inherently different. While Europe is generally approaching land management as a comprehensive and holistic challenge requiring strong government information and administration systems, Australia is creating layers of separate commodities out of land and adapting existing LAS as much as possible to accommodate this trading without a national approach. In these varying national contexts, the one commonality, the need for land information to drive land management in support of sustainable

development, will remain the universal land administration driver of the future. (Williamson and others, 2006b)

3. LAND MARKETS

As previously stated, the land market of 1940 is unrecognisable in today's modern market (Figure 6). Modern land markets evolved from systems for simple land trading to trading

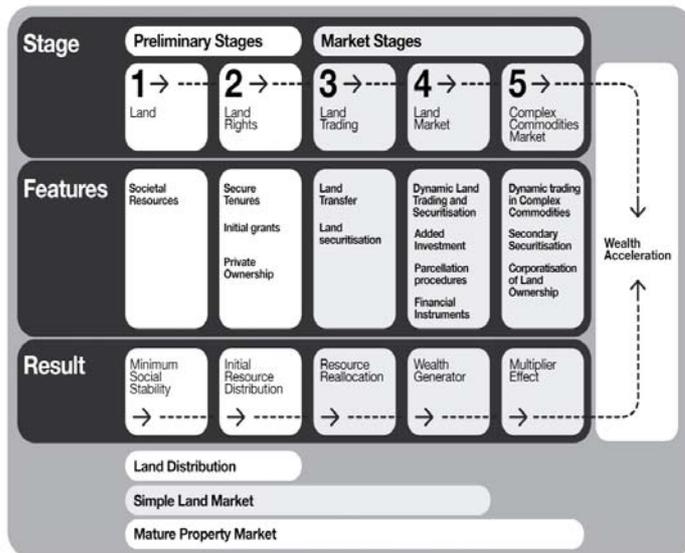


Figure 6 Evolution Of Land Markets (Wallace and Williamson 2006a)

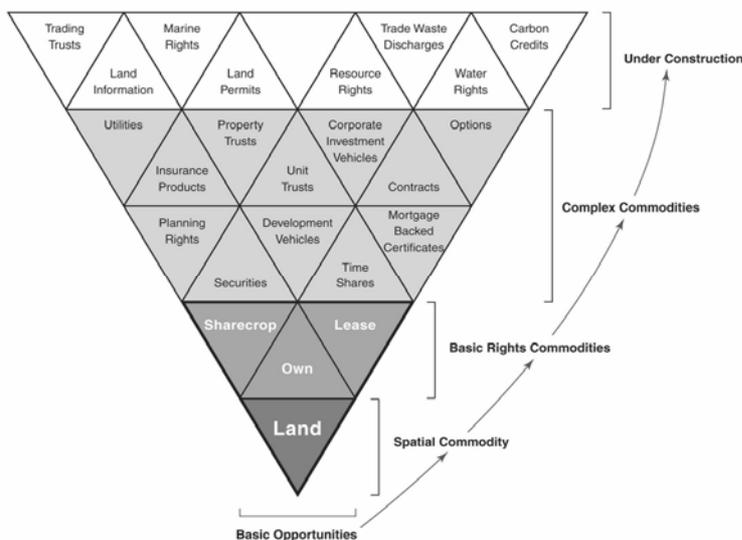


Figure 7 Complex commodities market (Wallace and Williamson, 2006a)

complex commodities. New trading opportunities and new products were, and continue to be, invented. The controls and restrictions over land became multi-purpose with an increasing focus on achieving sustainable development objectives.

As with simple commodities such as land parcels, all commodities require quantification and precise definition (de Soto, 2000). While LAS have not yet incorporated the administration of complex commodities to a significant degree, these modern complex land markets offer many opportunities for LA administrators and associated professionals, if they are prepared to think laterally and capitalise on their traditional measurement, legal, technical and land management skills.

This complexity is compounded by the “unbundling of rights in land” (ie water, biota etc) thereby adding to the range of complex commodities available for trading. For example, the replication of land related systems in resource and water contexts is demanding new flexibilities in our approaches

to land administration (Wallace and Williamson, 2006a). These emerging demands will stimulate different approaches to using cadastral information.

Our understanding of the evolution of land markets is limited, but it must be developed if LA administrators are going to maximise the potential of trading in complex commodities by developing appropriate land administration systems (Wallace and Williamson, 2006a). Figure 6 shows the various stages in the evolution of land markets from simple land trading to markets in complex commodities. The growth of a complex commodities market showing examples of complex commodities is presented diagrammatically in Figure 7.

4. THE IMPORTANCE OF SPATIAL DATA INFRASTRUCTURES

All LAS require some form of spatial data infrastructure (SDI) to provide the spatial integrity for rights, restrictions and responsibilities relating to land, and the resulting land information. However SDI is an evolving concept. In simple terms, it is as an enabling platform linking data producers, providers and value adders to data users. SDIs are crucial tools in facilitating use of spatial data and spatial information systems. They allow the sharing of data, which enables users to save resources, time and effort when acquiring new datasets. Many nations and jurisdictions are investing in developing these platforms and infrastructures to enable their stakeholders to adopt compatible approaches to creation of distributed virtual systems to support better decision-making. The success of these systems depends on collaboration between all parties and their design to support efficient access, retrieval and delivery of spatial information (Williamson and others, 2003).

The steps to develop an SDI model vary, depending on a country's background and needs. However, it is important that countries develop and follow a roadmap for SDI implementation. Aspects identified in the roadmap include the development of an SDI vision, the required improvements in national capacity, integration of different spatial datasets, the establishment of partnerships, and the financial support for an SDI. A vision within the SDI initiative is essential for sectors involved within an SDI project and for the general public. The SDI vision helps people to understand the government's objectives and work towards them. Unfortunately many land administrators under-estimate the importance of SDIs in building efficient and effective LAS. They focus on the immediate administrative needs and tasks to provide security of tenure and the support for simple land trading, a narrow focus that restricts the ability of LAS organizations to contribute to the whole of government and wider society through spatial enablement.

SDI as an enabling platform

Effective use of spatial information requires the optimisation of SDIs to support spatial information system design and applications, and subsequent business uses. Initially SDIs were implemented as a mechanism to facilitate access and sharing of spatial data hosted in distributed GISs. Users, however, now require precise spatial information in real time about real world objects, and the ability to develop and implement cross-jurisdictional and inter-agency solutions to meet priorities, such as emergency management, natural resource management, water rights trading, and animal, pest and disease control.

To achieve this, the concept of an SDI is moving to a new business model, in which the SDI promotes partnerships of spatial information organisations (public/private), allowing access to a wider scope of data and services, of greater size and complexity than they could individually provide. SDI as an enabling platform can be viewed as an infrastructure linking people to data (Rajabifard and others, 2006) through linking data users and providers on the basis of the common goal of data sharing (Figure 8). However, there is a need to move beyond a simple understanding of SDI, and to create a common rail gauge to support initiatives aimed at solving cross-jurisdictional and national issues. This SDI will be the main gateway through which to discover, access and communicate spatially enabled data and information about the jurisdiction.

According to Masser et al (2007), the development of SDIs over the last 15 years, and the vision of spatially enabled government, have many parallels, but there are also important differences. The challenge is to develop an effective SDI that will support the vast majority of society, who are not spatially aware, in a transparent manner. All types of participating organisations (including governments, industries, and academia) can thus gain access to a wider share of the information market. This is done by organisations providing access to their own spatial data and services, and in return, becoming contributors, and hence gaining access to the next generation of different and more complex services. The vision is to facilitate the integration of existing government spatial data initiatives for access and delivery of data and information. This environment will be more than just the representation of feature based structures of the world. It will also include the administration and institutional aspects of these features, enabling both technical and institutional aspects to be incorporated into decision-making. Following this direction, in Australia for example, researchers have defined an enabling platform called *Virtual Australia* (Rajabifard and others, 2006). The concept and delivery of Virtual Australia aim to enable government and other users from all industries and information sectors to access both spatial information (generally held by governments) and applications which utilise spatial information (developed by the private sector and governments). The next step in the evolution of SDIs is their role as an enabling platform in support of a spatially enabled society (Rajabifard, 2007).

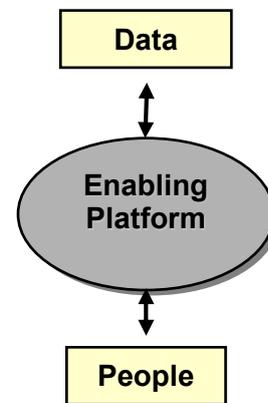


Figure 8: SDI connecting people to data

SDI and Sustainable Development

While SDIs play an essential role in supporting LAS, they also have a wider role in supporting sustainable development objectives. Achievement of sustainable development is not possible without a comprehensive understanding of the changing natural environment, and monitoring the impact of human activities by integrating both the virtual representations of the built and natural environments. Despite the significance of data integration however, many jurisdictions have fragmented institutional arrangements and data custodianship in the built and natural information areas. For example, the land administration, cadastral or land titles office (which has a key role in providing built environment, people relevant, data) is often separated from state or national mapping organizations which have the responsibility of managing the natural environment data. This fragmentation among data custodians has brought about a diversity of approaches in data acquisition, data models, maintenance and

sharing. Many countries are attempting to address these inconsistencies through development of national SDIs. However, further steps of a framework and associated tools to facilitate integration of multi-sourced data, are also needed. (Mohammadi and others, 2006 and 2007). An SDI can provide the institutional, administrative, and technical basis to ensure the national consistency of content to meet user needs in the context of sustainable development.

5. THE CONTRIBUTION OF LAND ADMINISTRATION SYSTEMS TO *iLand*

This brief review of the evolution of cadastres, land administration systems, SDIs and land markets shows that the traditional concept of cadastral parcels representing the built environmental landscape is being replaced by a complex arrangement of over-lapping tenures reflecting a wide range of rights, restrictions and responsibilities, and that a new range of complex commodities, building on this trend, has emerged. To a large extent these developments are driven by the desire of societies to better meet sustainable development objectives. There is no reason to believe that this trend will not continue as all societies better appreciate the needs to manage the environment for future generations and deliver stable tenure and equity in land distribution.

While the growth of complex commodities offers huge potential for cadastral systems to play a greater role in delivering sustainable development objectives and supporting the trading of these complex commodities in particular, one complex commodity, land information, is capable of transforming the way government and the private sector do business. The potential offered by land information in a virtual world in spatially enabling government is so large, it is difficult to contemplate. We are starting to glimpse this potential in such initiatives as Google Earth and Microsoft's Virtual Earth, but this is barely a start. These predictions of the importance of spatial information are also recognized in many influential forums including in the prestigious journal NATURE, and in the Australian Prime Minister's statement on frontier technologies for building and transforming Australia's industries (December, 2002) – both these examples place the growth and importance of the geosciences alongside nanotechnology and biotechnology as transformational technologies in the decade ahead.

With regard to the importance and growth in land administration and its cadastral core as shown in Figure 4, Figure 9 (Williamson, 2006) uses a technology focus to show the transformation of land administration and cadastral systems over the last three decades or so. The figure shows five stages in the evolution of our cadastral systems from a technology perspective. The first stage recognizes that historically cadastral systems were manually operated with all maps and indexes hard copy. At this stage, the cadastre focused on security of tenure and simple land trading. The 1980s saw the computersiation of these cadastral records with the creation of digital cadastral data bases (DCDBs) and computerized indexes. While this computerization did not change the role of the land registry or cadastre, it was a catalyst felt world wide, initiating institutional change to start bringing the traditionally separate functions of surveying and mapping, cadastre and land registration together.



Figure 9 Technical evolution of land administration

With the growth of the Internet, the 1990s saw governments start to web enable their land administration systems as they became more service oriented. As a result, access over the Internet to cadastral maps and data was possible. This facilitated digital lodgment of cadastral data and opened up the era of e-conveyancing. However, the focus on security of tenure and simple land trading within separate institutional data silos still continued. At the same time, this era also saw the establishment of the spatial data infrastructure (SDI) concept (see Williamson and others, 2003 and Rajabifard and others, 2005). The SDI concept, together with web enablement, stimulated the integration of different data sets (and particularly the natural and built environmental data sets) with these integrated data sets now considered critical infrastructure for any nation state.

Now a significant refinement of web enabled land administration systems aims to achieve interoperability between disparate data sets, facilitated by the partnership business model. This marks the start of an era where basic land, property and cadastral information can form an integrating technology between many different businesses in government, such as planning, taxation, land development and local government. An example is the new Shared Land Information Platform (SLIP) being developed by the state Government of Western Australia (Searle and Britton, 2005). A key catalyst for interoperability is also the development of high integrity geocoded national street address files, such as the Australian GNAF (Paull and Marwick, 2005 and PSMA, 2007). Similarly, “mesh blocks”, small aggregations of land parcels, are revolutionizing the way census and demographic data is collected, managed and used (Toole and Blanchfield, 2005). These refinements potentially extend to better management of the complex arrangement of rights, restrictions and responsibilities relating to land that are essential to achieving sustainable development objectives (Bennett and others, 2005, 2008a and 2008b). They also stimulate re-engineering of cadastral data models to facilitate interoperability between the cadastre, land use planning and land taxation for example (Kalantari and others, 2005, 2006 and 2008).

The future focus will be on realising the potential of land and cadastral information. The use and potential of cadastral data as an enabling technology or infrastructure will outweigh its value to government from supporting simple land trading and security of tenure. Cadastres will not stop at the water’s edge; they will include a marine dimension where there is a continuum between the land and marine environments. Without this basic infrastructure the management of the exceptionally sensitive coastal zone is very difficult, if not impossible (Strain et al, 2006; Wallace and Williamson, 2006b, Vaez and others, 2007).

However this is not the end of the story – researchers, practitioners, big business and government see the potential from linking “location” or the “where” to most activities, policies and strategies, just over the horizon. Companies like Google and Microsoft are actively negotiating to gain access to the world’s large scale built and natural environmental data bases. In Australia, they are negotiating to get access to the national cadastral and

property maps as well as to GNAF. At the same time, new technologies are being built on top of these enabling infrastructures such as the Spatial Smart Tag which is a joint initiative in Australia between government, the private sector and Microsoft (McKenzie, 2005). We are starting to realise that cadastral and land related information will dramatically spatially enable both government and the private sectors, and society in general. In the near future, spatially enabled systems will underpin health delivery, all forms of taxation, counter-terrorism, environmental management, most business processes, elections and emergency response, for example (see for example and Rajabifard, 2007 and OSDM, 2007).

In the future, cadastral data will be seen as information and a new concept called *iLand* will become the paradigm for the next decade. *iLand* is a vision of integrated, spatially enabled, land information available on the Internet. *iLand* enables the “where” in government policies and information. The vision as shown diagrammatically in Figure 10 is based on the engineering paradigm where hard questions receive “design, construct, implement and manage” solutions. In *iLand* all major government information systems are spatially enabled, and the “where” or location provided by spatial information is regarded as a common good made available to citizens and businesses to encourage creativity, efficiency and product development. The LAS and cadastre is even more significant in *iLand*. Modern land administration demands LA infrastructure as fundamental if land information is to be capable of supporting those “relative” information attributes about people, interests, prices, and transactions, so vital for land registries and taxation.

All these initiatives come together to support a new vision for managing land information - *iLand*. (Williamson, Wallace and Rajabifard, 2006)

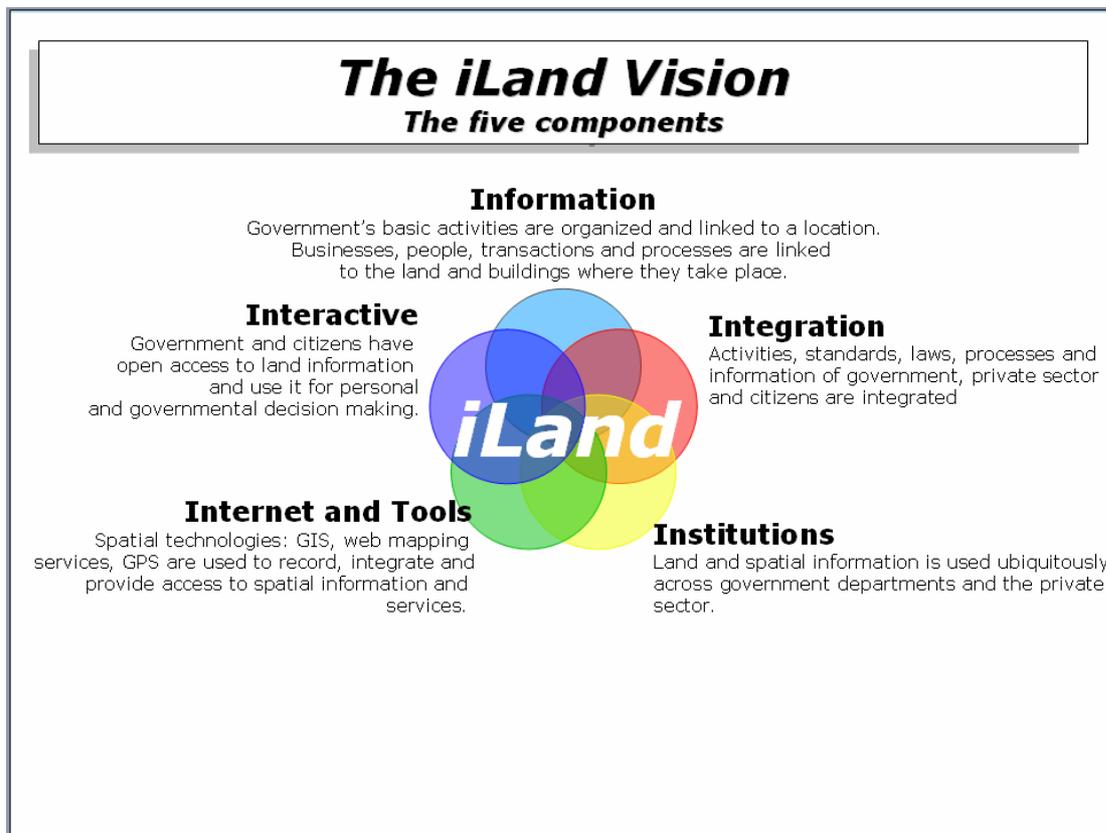


Figure 10 – The *iLand* Vision
(Williamson and Wallace, 2006)

While future markets of complex commodities will continue to rely on the underlying cadastre and land administration system, will LA administrators embrace the definition and management of complex commodities that do not rely on traditional cadastral boundaries and that require merging of value, building purpose, land use and personal owner information? How many LA administrators are capable of seeing the international context of land information and its importance to their national government in presentation of its investment face to the world? Will they embrace *iLand*?

6. THE ROLE OF CADASTRES AND LAND ADMINISTRATION IN SPATIALLY ENABLING GOVERNMENT

Governments can be regarded as spatially enabled when they treat location and spatial information as common goods made available to citizens and businesses to encourage creativity and product development. The vision of a spatially enabled government involves establishing an enabling infrastructure to facilitate use of place or location to organise information about activities of people and businesses, and about government actions, decisions and policies. Once the infrastructure is built, spatial enablement allows government information and services, business transactions and community activities to be linked to places or locations. Given the potential of new technologies, use of place or location will facilitate the evaluation and analysis of both spatial and non-spatial relationships between people, business transactions and government. (Williamson and Wallace, 2006; Rajabifard, 2007; OSDM, 2007; and PCGIAP, 2007)

Most governments already have considerable infrastructure and administrative systems for better management of land and resources. Basic information creating processes are cadastral surveying that identifies land; its supporting digital cadastral database (DCDB) that provides the spatial integrity and unique land parcel identification; registering land that supports simple land trading (buying, selling, mortgaging and leasing land); running land information systems (LIS) for land development, valuation and land use planning; and geographic information systems (GIS) that provide mapping and resource information. For modern governments at all stages of development, one question is how best to integrate these processes, especially to offer them in an Internet enabled *eGovernment* environment.

Twenty years ago, each process and collection of information, was distinct and separate. Two changes in the world at large challenged this silo approach. First, thanks to improvements in technology, the infrastructure available to support modern land and resource management now spans three distinct environments: the natural, the built and the virtual environments. Second, the pressures on managers created by increased populations, environmental degradation, water scarcity and climate change, require governments to have more accurate and comprehensive information than ever before.

How governments treat their land information will define their transformation of internal and external processes. The *eLand* administration concept as part of *eGovernment* initiatives is now moving to a wider use of spatially enabled land information, expressed in the concept of *iLand* - integrated, interactive spatial information available on the Internet. The conversion of processes to spatially enabled systems will increase useability, access and visualisation of information.

7. THE ROLE OF THE CADASTRE IN SUPPORTING SUSTAINABLE DEVELOPMENT

These developments and drivers will introduce complexity into the design of LAS as they adapt to assist delivery of a broader range of public policy and economic goals, the most important of which is sustainable development. However re-engineering land administration systems to support sustainable development objectives is a major change in direction for traditional LAS and is a significant challenge (Enemark and others, 2005).

In the proceeding sections this paper has described how cadastres, SDIs and LAS interact to spatially enable government and wider society in pursuit of sustainable development objectives. These relationships are shown diagrammatically in Figure 11 below. The diagram shows the critical role that the cadastre plays in providing built environmental data in a national SDI and how the integrated SDI can then contribute to a LAS that supports effective land management. It is only by bringing together the SDI and the LAS that an integrated land policy can be implemented to support sustainable development. This integration also provides the key role of spatial enablement of the LAS, as well as government and wider society. Ironically only a relatively small number of countries, the “developed countries” have the ability at the present of achieving this objective. However the model does provide a road map for less developed countries to move down this path.

Building Land Administration Infrastructure

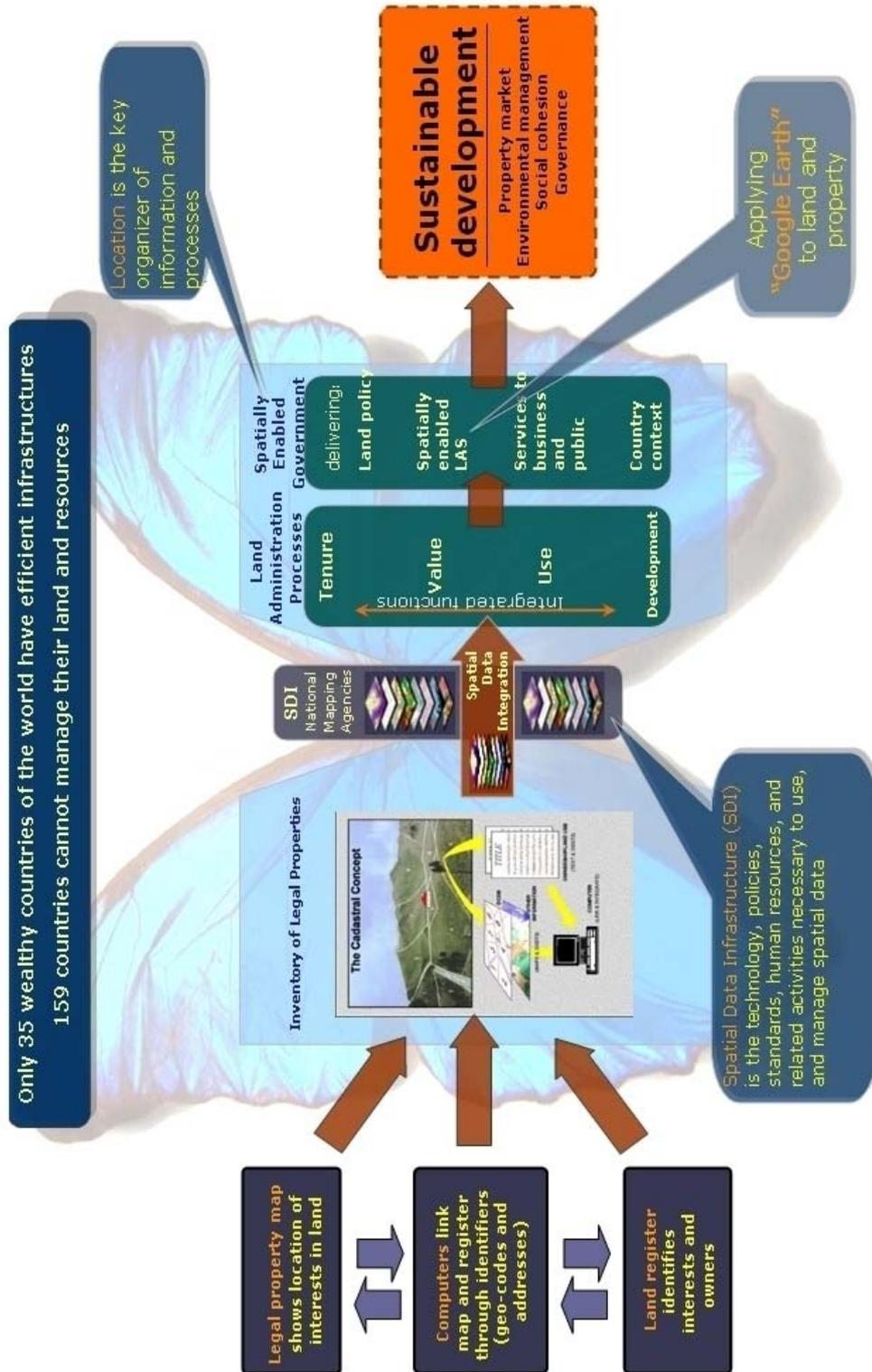


Figure 11

The role of the cadastre in building land administration infrastructures

These global trends to move LAS down this path, and the national and historical methods used to incorporate sustainable development objectives into national LAS were examined in an Expert Group Meeting (EGM) in Melbourne in December, 2006 with leading stakeholders and land policy experts from Australia and Europe. (Williamson and others, 2006a). Distinctions between approaches used in modern European democracies and in Australia were identified. The European approach showed more integration between the standard LAS activities and measures of sustainability. Australian policy was more fractured, partly due to federation and the constitutional distribution of powers. In contrast, pioneering in Australian LAS lay in incorporating market based instruments (MBI) and complex commodities into LAS, and revitalization of land information through inventive Web based initiatives.

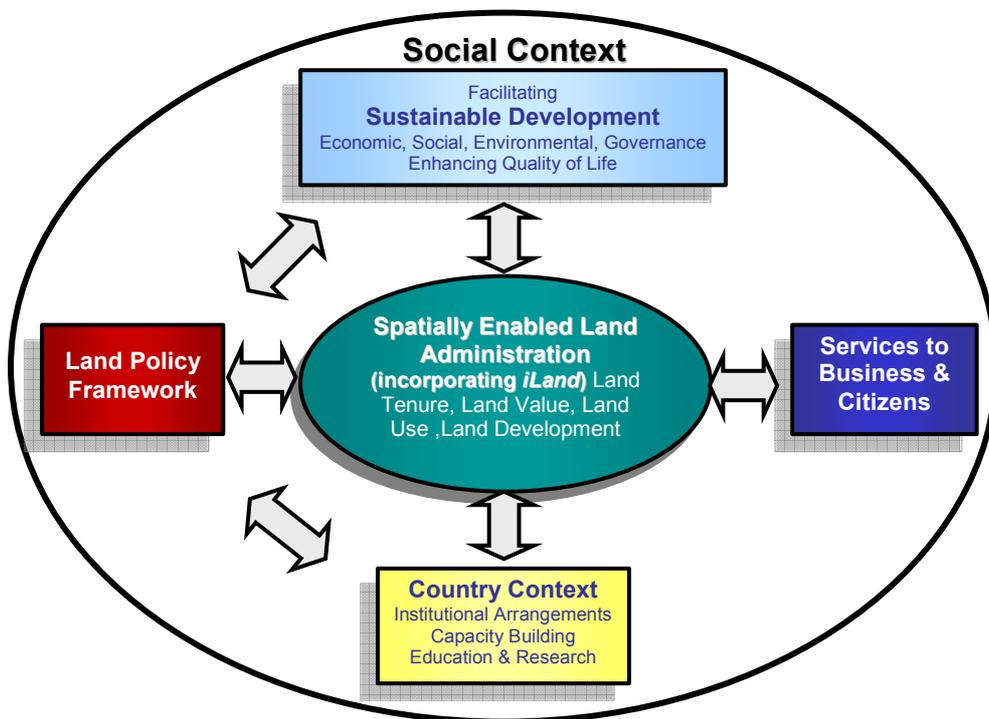


Figure 12 – Land management vision
(Williamson and others, 2006b)

The EGM developed a vision for future LAS sufficiently flexible to adapt to this changing world of new technology, novel market demands, and sustainable development, as shown in Figure 12. This vision incorporates and builds upon the above vision of *iLand* and can be considered an infrastructure or enabling platform to support spatial enablement of government. (Wallace and others, 2006; Williamson and others, 2006a and 2006b). This vision is explained at a more practical level in Figure 11 above.

8. CONCLUSION

People to land relationships are dynamic. The land administration and cadastral responses to managing these relationships are also dynamic and continually evolving. A central objective

of the resulting land administration systems is to serve efficient and effective land markets. Because of sustainable development and technology drivers, modern land markets now trade in complex commodities, however our current land administration systems and the majority of the skills of land surveyors, lawyers and LA administrators are focused on the more traditional processes supporting simple land trading. The growth in complex commodities offers many opportunities for LA administrators if they are prepared to think laterally and more strategically.

Land information has grown in importance over the last few decades, and is considered by many to be more important and useful to government than in its traditional role of supporting security of tenure and simple land trading. Land administration systems and their core cadastral components are evolving into a new vision and essential infrastructure called *iLand* that spatially enables government and provides the “where” for all government decisions, policies and implementation strategies. This vision requires a clear understanding and institutional and legal structures that link the cadastre to the SDI and the wider LAS. Without this understanding and interaction delivering the vision is very difficult if not impossible. Ultimately, spatially enabled land information will provide the essential link between land administration and sustainable development.

This brief account of the future delivers a challenge to land administration officials to design and build modern land administration and cadastral systems capable of supporting the creation, administration and trading of complex commodities, and particularly to use land information to spatially enable government and society in general. Unfortunately, unless land administration systems are refocused on delivering transparent and vital land information and enabling platforms, modern economies will have difficulty meeting sustainable development objectives and achieving their economic potential.

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