Spatially Enabling Land Administration: Drivers, Initiatives and Future Directions for Australia

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Abstract

Spatially enabled societies demand accurate and timely information about land. Australia's land administration systems are state and territory based, administered by independent agencies. These arrangements have served the nation well. However, Australia's increasingly national economic, environmental, and social management priorities challenge their design and capacity. Land management issues now require approaches based on need, not jurisdiction. Information to found sound policymaking at a national level is also essential. Indeed, a national infrastructure for managing land information is an obvious tool needed by governments at all levels: national, state and territory and local. Given Australia's complex federal arrangements, an infrastructure built on existing systems that negates the need for a new national federal agency appears to be the optimal approach. In order to achieve this workable national infrastructure, eight design elements must be developed: a shared vision, a common language or ontology, a governance framework, a business case for change, selection of a data model, an accompanying technical infrastructure, an implementation/maintenance model, and an international compatibility framework. An analysis of the key national drivers and emerging international initiatives is needed to ensure that these elements, and any others that are identified, suit national needs. Extensive future research is required to achieve each of the eight design elements in the context of drivers and global trends.

Keywords: spatially enabled society, land administration, land information, national infrastructure

1.   INTRODUCTION

Spatially enabled societies demand accurate and timely information about land: land information provides the link between people and activities. In Australia, land administration has always been a state responsibility: information relating to tenure, valuation, development and land use is neither created nor managed at the national level.

This situation presents challenges when issues requiring national land datasets emerge. For example, it is difficult to conduct an effective national census without an authoritative geo-coded register of addresses and land parcels. Verification of where people live is difficult and the extensive analytical possibilities provided by the spatial attribute are not available. Australia now possesses these national datasets. However, many other instances where national, timely land information is essential still exist. Australia, and all nations, requires national land information frameworks if they desire to achieve spatially enabled societies and the greater goals of sustainable development and good governance.

Australia already has a number of building blocks in place for a national land information framework. Strong relationships between the states and the federal government are fostered through the Australian New Zealand Land Information Council (ANZLIC). The Intergovernmental Committee on Surveying and Mapping (ICSM) coordinates the development of national technical standards relating to data production, storage, and dissemination. Management of relationships among the key agencies by the PSMA Australia Limited (PSMA Australia), an unlisted public company owned by the governments of Australia, has delivered national datasets by coordinating the aggregation of state datasets. Information sets include administrative boundaries, cadastral parcels, addresses, topography, postcodes, points-of-interest and transport (Paull, 2009).

These building blocks have served Australia well over the last decade; however, they are only a starting point. Large amounts of disaggregated land data and transaction processes remain at the state and local levels. Moreover, as spatial technologies become more ubiquitous, many new initiatives are emerging from the federal government, the private sector, and national coordination bodies, sometimes in non-traditional land administration sectors. Any new concept of a national infrastructure for managing land information must be built on existing achievements. While acknowledging the success of Australia's spatial industry, a clear national vision or framework for organizing land information appears to be lacking.

This paper aims to explore the need and nature of a national land administration infrastructure in the Australian or federated context. While the need for these systems is generally agree upon at different levels of government across different countries (c.f. United States), the drivers and design elements have not been researched quantitatively or qualitatively in the Australian context. The paper uses an exploratory research method to understand the nature and design of a national infrastructure for managing Australia's land information. The drivers requiring national datasets and the activities and changes required to deliver them are studied. The land datasets and administrative processes requiring aggregation also receive attention. To deliver new services and products on a national scale, policy, legal, institutional, and technical elements of a suitable framework are also investigated.

2. DESIGNING THE INFRASTRUCTURE: METHOD AND APPROACH

Preliminary studies have been undertaken into the nature and design elements of a national infrastructure for managing land information within Australia. They are based around an exploratory case study, as opposed to descriptive and explanatory case studies (c.f. Yin, 1993), of the Australian context. The case study was qualitative in nature. First, it focused on identifying national and federal drivers through analysis of prominent problem cases emerging from reports by peak industry bodies (e.g. Real Estate Institute of Australia) and parliamentary inquiries conducted by the Australian Federal Parliament over a period of five years (2005-2010). Second, Australia's existing land administration arrangements were reviewed to identify limitations and opportunities. Third, emerging technologies and their applicability to the Australian context were studied. This lead to the creation of the design elements and determination of future research directions (Figure 1).

Figure 1. Research Approach
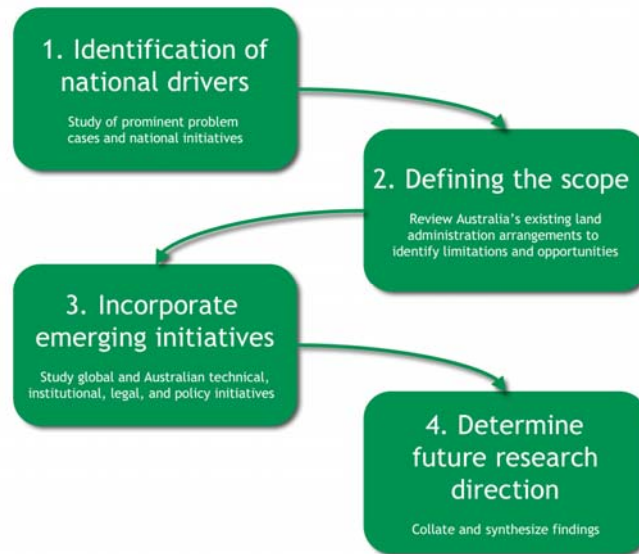
3. IDENTIFICATION OF THE NATIONAL DRIVERS

The drivers for a national land information infrastructure are complex and change frequently, as political, scientific and environmental debates raise policy issues. For convenience, the drivers can be classified into the following categories: economic management, environmental management (built and natural), social management, harmonized governance, and technological possibilities (Figure 2).

Figure 2. National Drivers for an Infrastructure to Manage Australian Land Information

3.1 Economic management

Land in Australia is a fundamental resource for economic activity. Land as a physical commodity is subject to economic forces of supply and demand similar to any commodity or service (Jeffress, 1991). The greater the demand for land, the higher the value of the land. The economic theory of derived demand suggests that the demand for land information and public access to the information is tied to the increasing value of land and increasing complexity of the land related commodities. The increased value of land information should lead to improvements in recording procedures to deliver more cost effective access to land information resources.

In Australia, trends towards sharing land information are more obvious than ever before. Institutional barriers to SDIs are rapidly diminishing. The need to share data to solve state and federal issues is increasingly recognised. For example, a seamless national economy such as that espoused by the Council of Australian Governments

Reform Council (COAG Reform Council, 2009) demands data sharing by those contributing to and governing the economy. Information sharing was also recognized in the 'National Market for Retail Leases' report prepared by the Australian Government's Productivity Commission (Australian Government Productivity Commission, 2008). From an economic perspective, the need to present land and property information on a coherent national scale is now undeniable. A national infrastructure for land information in Australia is the next step to achieving greater economic efficiency in land administration.

The transferability of rights in land underpins an active and secure land market that plays a key role in the country's economic situation. However national banks, insurers, property and superannuation funds, and developers struggle with the jurisdiction based laws and processes in a market that is increasingly national in focus. Australians are increasingly mobile and expect land markets to have similar features throughout the nation. At the macro-economic level organizations such as the Reserve Bank of Australia (RBA) require national property information to make informed decisions about national monetary policy. Currently, authoritative land transaction and ownership information is the domain of the states: there is no requirement for the states to deliver this information to national agencies. A more collaborative solution appears necessary.

Another example is taxation of land. Australia collects tax from land at all three level of government: through Capital Gains Tax (CGT) and Goods and Services Tax (GST) at the federal level, Land Tax and Stamp Duty at the state level, and Council Rates at the local level. Effective land taxation requires reliable information about property location, ownership, values, and the people and entities who enter or intend to enter the market, either as owners or renters. The federal level has no jurisdiction over these datasets. A good example of potential stress on the existing system involves the levying and collection of CGT, a tax paid on devolution of assets such as property levied according to increases in value. The levying relies on access to authoritative property information, however, the federal government, not the states, collects CGT. The Australian Tax Office (ATO) does not have authoritative and direct access to the ownership information held by the states. Therefore, the successful levying of capital gains tax in relies on taxpayer reporting and second level information sets accumulated by the federal government.

Australia has "unbundled" interests in land and resources, and enjoys multiple markets in complex commodities related to land (Wallace and Williamson, 2006). This modern land market needs seamless national datasets for economic management. Unbundling has opened up new sources of economic activity for the nation. Ownership information for the complex rights, restrictions and responsibilities (RRRs) associated with land is critical in the enforcement of a wide range of laws and regulations (Bennett *et al*, 2008). Additionally, assignment and maintenance of ownership information are important administrative tasks required to support marketing and exchange of property rights in biota, carbon, water, environmental interests, conservation arrangements, property investment schemes and more.

These initiatives must be accommodated within a nationally consistent land tenure infrastructure in order to sustain a globally competitive land market that continues to attract international investment and reasonably priced credit. These increasingly global markets in money and property demand that the cadastral structure of land parcels be refocused to deliver information about new property objects at a national level.

3.2 Natural and Built Environmental Management

Environmental management also requires access to national datasets: the natural environment does not respect state borders. The administrative arrangements in the Murray-Darling Basin provide a good example of the irrelevance of jurisdictional borders. Effective management of cross-border situations increasingly requires access to national land data sets.

Drought relief provides another example. The Australian Government provides financial assistance to farmers affected by prolonged drought, in the form of a 'Farmers Income Support Payment'. To be eligible for this assistance a farmer must be living in an 'exceptional circumstances' declared area. Centrelink, an agency operated by the Commonwealth government, is responsible for allocating the assistance. Centrelink, like the rest of the federal government, has limited access to parcel and property information. To fill the gaps, farmers who apply for an exceptional circumstances income support payment are required to provide Centrelink with the addresses of their farms (accompanied by rates notices), and a hand drawn maps of its location (including property boundaries, roads, and towns all with approximate distances). This immature spatial representation is used by Centrelink to verify that location of farms within exceptional circumstances drought declared areas. In the past, these inadequate arrangements led to difficulties in validation of claims and identification of fraudulent claims.

Drought relief examples bring into focus the broader case of disaster management. Many Australian disasters, including floods, cyclones, bushfires, locust plagues, and spreading livestock disease, are unconstrained by state and territory borders. However, they continue to be managed within jurisdictional confines. These land administration inadequacies combine with jurisdictional, institutional, and human obstacles to impact on disaster management at all government levels. In many cases, access to a national land information framework would radically improve disaster mitigation, preparedness, response and recovery.

Management of the built environment also requires national land information. In December 2009 COAG called for all Australia's capital cities to have strategic development plans in place by 2012 (COAG, 2009). These plans will be used by the Commonwealth to ensure that federal spending on city infrastructure is appropriate and strategic. To analyze these strategic plans, the federal government will require integrated land information from all states.

The dynamics of housing provision also shed some light on the need for a national framework to manage land information. Processes of adding housing units to existing stock require the collation and analysis of several data sets throughout various hierarchies of government - federal, state and local. These processes strike disparate land use planning strategies that might be better integrated into a national approach involving both land use planning strategies and information management. Ultimately the national scale approach would improve understanding of how strategies influence agencies and people engaged in housing production including land owners, developers, financial institutions, planning authorities, building contractors, professionals in the building industries, and their parties that might be impacted by development proposals.

Identification and mitigation of risks to infrastructure and the natural environment along the coastal zone also demand aggregated land and property information at the national level (DCC, 2009). Indeed, the Australian Parliament's Standing Committee on Climate Change, Water, Environment, and the Arts recently recommended the

development of a national coastal land information database (SCCCWEA, 2009; COAG, 2009).

3.3. Social management

Governing the activities of people and communities also demands access to land information on a national scale: land information allows people, communities, and their activities to be linked. Responding to organized crime on a national level (e.g. stolen vehicle syndicates) and allocating welfare and relief funding demand such an approach. The requirement was perhaps first made clear prior to the Sydney Olympics in 2000 and after 9/11 when the need to monitor potential terror cells demanded access to national land information sets.

Law enforcement and emergency management are state activities. The agencies responsible for these activities are usually restricted to their own jurisdiction. The datasets these organizations hold are often rarely aggregated, impeding the operation of national law enforcement and emergency management agencies. Law enforcement and emergency management responses are reliant upon the parcel and address layers: they link people and activities to an identifiable position. A national infrastructure that links state land information would also act as a platform for a wide range of other non-land related activities (e.g. law enforcement) and datasets to be linked.

The current federal government's desire to include 'Social Inclusion' principles in all decision making will also need to be underpinned by national datasets that link people, place, and societal activities. For example, on the pro-poor scale, Australia's capacity to analyze housing needs (numbers, type of housing, and preservation of land for essential food production) is also in need of improved demographic information with geocoded analytical facilities.

3.4 Harmonized governance

Good governance is often described as the fourth pillar of sustainable development. Increasingly, harmonized governance is seen as being an important part in delivering good governance. Harmonized governance attempts to reduce legal and administrative complexities for citizens by demanding that different arms and levels of government integrate their responsibilities and administrative process. The need to harmonize the governance systems of different states and the federal governments is recognized by most stakeholders. Harmonization can save millions of dollars and radically improve the ability of businesses, communities and governments to operate on a national level (SCLCA, 2006; SCLCA, 2008). Meanwhile, private sector frustrations about inadequate and out of date arrangements continue to grow. The national umbrella organizations all see benefits in more timely and seamless spatial and land information.

3.5 Technological possibilities

Spatial information and technologies are changing the way business and governments manage activities and solve problems. Much information relates to place and locations. Some of this is spatial information, but a great deal is information that can be organized according to its impact on a place.

Global technology companies such as Google and Microsoft are the popular players in this paradigm shift (Butler, 2006; Bennett, 2007). Google's easily accessible Web 2.0 friendly web mapping platforms have commoditized once

complex and expensive GIS processes. Additionally, freely available high-resolution imagery and 3D visualization tools have demonstrated the power of spatial information. Users of government information systems increasingly demand this level of visualization and functionality.

The contemporary information revolution is not only about merging phones and computers. The commoditization of spatial information management platforms allows SDI practitioners to move their focus from organizing spatial information to *spatial organization of information*. This involves using place information as a sorting and accessing method for handling masses of other information.

These emerging spatial technologies potentially expand the capacity of governments. They provide possibilities for ordering information that are profoundly world changing. The more difficult task involves embedding new technologies into the most conservative and fundamental processes in land information and management of the land market, particularly, into the land registries. Regardless, the opportunities provided by emerging technologies are driving changes in the way governments interact with their citizens, principally in initiatives to spatially enable their processes, as well as their information.

4.   DEFINING THE SCOPE AND COMPONENTS

Based on the analysis of national drivers, at least eight design elements are required to deliver a national infrastructure to manage land information in the Australian context (Figure 3).

Figure 3. Design Element for a National Infrastructure to Manage Land Information
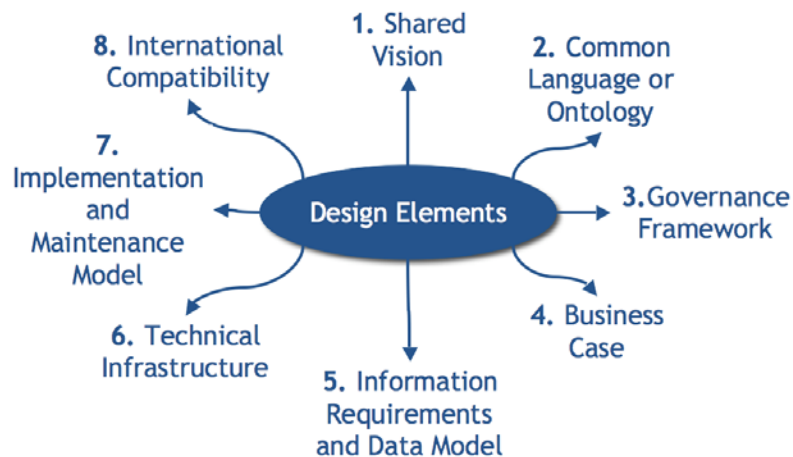
4.1 Shared vision

While the need for a national infrastructure is now clear, its characteristics and functionality are not. How the underlying policy, legal, institutional, and technical components should be built and governed remains unresolved. Some suggestions envisage a relatively simple postbox system for lodging land registrations to the respective state based systems using a single point of entry and streamlined, single electronic data entry building on national electronic conveyancing ideas. This is not dissimiliar to the approach used successfully by PSMA Australia where the States and Territories lodge their respective datasets for integration and dissemination on a national basis. More radical visions involve integrated transaction management delivering authoritative information relating to addresses, valuations, tenures,

development processes, planning systems, and the management of complex commodities. Integration of land information with other datasets covering people, business and legal entities, vehicles, and others, following the European Union idea of authoritative registers, is also worth considering. Australia's existing successes suggest a middle ground opportunity that utilizes pre-existing initiatives into a coherent framework shared by key stakeholders. Issues of data inclusion, data currency and data authenticity all need assessment. The development of this vision will require relationship management beyond state and national governments, and should include local governments, and private sector stakeholders in community and business sectors.

4.2 Common languages or ontology

Attempts by researchers and jurisdictions to create ontological frameworks for management of land information are now common. The European Union developed a process-based ontology for managing property transactions through comprehensive activity diagrams that allow comparisons in EU countries (Hess and Schlieder, 2009). These analyses of property processes allow a seamless approach to the local detail in each jurisdiction, overcoming the differences between land registration and deed registration approaches in property sales and mortgages. The idea is particularly fertile for Australia.

An example in Australia of similar activity is ANZLIC's efforts through its Standing Committee for Land Administration and Property Rights (SCOLA) which has been working for some time on establishing a national set of principles for consistent characterization of property interests to facilitate electronic enablement and Web-based access. Work of this nature is critical to developing the necessary common language to support a national infrastructure.

4.3 Governance framework

A governance framework is essential. The nature of this framework needs determination. Arrangements relating to policy, legal, and institutional aspects must survive changes of government, administrative fashions and budgetary priorities. In relation to policy, the guiding principles of the framework need determination. Legal principles to guide changes to existing legislative frameworks need to be articulated. For example, the ability to use the data as evidence in Australia's courtrooms and tribunals is essential. Whether a minimalist or maximalist approach to legal changes is best also needs analysis. This also applies to institutional arrangements, should a new framework attempt to reorganize the functions of entrenched land administration agencies. The preferred relationship between three levels of government, peak national bodies, and the private sector needs to be determined, as does the role of public/private partnerships.

4.4 Business case

Satisfactory performance of the infrastructure is crucial to its sustainability and must be underpinned by a strong business case. The infrastructure must be financially attractive to use and simultaneously assured of sufficient income to expand incrementally in terms of its usage and data sets. Whether the national approach focuses on providing information or delivering transaction capabilities needs to be determined. The efficiencies and cost savings for participants, users and customers will need to be quantified and assessed against the cost of all proposed systems.

4.5 Data typologies and data model

In the longer term the ideal situation would see all forms of land information seamlessly integrated into a national framework. Data relating to tenure, valuation, development, planning, the environment, topography, demographics, imagery and the land market would be included. A subset of this information would form candidates for initial consideration. Emulation of the PSMA Australia model of cooperative relationship management could build on their existing product base of information relating to cadastral parcels, addresses, and administrative boundaries.

A data model is also required. Australia through ICSM has already developed the Harmonized Data Model in order to standardize state, land related datasets. However, the applicability of the Harmonized Data Model still requires testing in a range of contexts. In Europe, the Core Cadastral Domain Model or Land Administration Domain Model has been in development for almost a decade (van Oosterom *et al,* 2009). The move in this model towards property objects as opposed to land parcels greatly strengthens the model particularly in its ability to support the management of property rights, restrictions, and responsibilities (RRRs) and other non-parcel issues. Processes are currently being undertaken for this model to gain ISO accreditation. The applicability of this model to the Australian context requires investigation.

4.6 Technical infrastructure

A technological infrastructure to enable the data sharing is an essential design feature. The role of next generation web mapping tools, open source land administration architectures (Hall and Hay 2009), and 3D visualization platforms need careful evaluation: these tools will be integral parts of any solution over the next decade. An assessment of the appropriateness of tools ranging from LandXML, which simply allows land information to be shared between applications, to OWL, the Web Ontology Language, designed for use by applications that need to process the content of information, also needs to be made.

The integration of the proposed framework with the existing infrastructure currently utilized by each of the states and territories such as Western Australia's Shared land information platform (SLIP) and PSMA Australia's LYNX platform, the National Electronic Conveyancing system currently being established, and the National Address Management Framework (NAMF), also needs exploration.

4.7 Implementation and maintenance models

A plan for implementation identifying costs involved and timelines needs to be articulated. Given Australia's complex federalism, achievement of a functional national model within a single project is impossible. An incremental growth plan driven by successful modules to perform identified functions may be the ideal approach.

The maintenance of any new infrastructure is problematic. Historically, outputs of many national projects cease on completion of the construction phase because insufficient planning and resources are not available to ensure sustainability. Great care is needed to preserve in-house competence and ownership of the all parts of any national infrastructure, including budget allocations among the partners and related agencies for national priorities. Similar issues also emerge if existing institutions and agencies are reconstructed, particularly the loss of the internal knowledge base. Systems for maintaining and, especially, updating any new

infrastructure need to be identified in at the initial conceptual stage and built to deliver sufficient institutional, financial and human capital for the long haul.

4.8 International compatibility

Designers of a framework for integrating national land information must look beyond Australia's borders and ensure interoperability with international standards. Whilst not essential in the current context, the ability for land information systems to interact on a global level will become increasingly important, particularly as global land markets mature.

5.   INCORPORATING EMERGING INITIATIVES

The analysis of the Australian and international contexts revealed a range of initiatives relating to national or standardized approaches to managing land information. The Australian, European, and United States contexts are discussed here.

5.1. Australian initiatives

Australia is at the forefront of integration of information. Agitation for a national framework to manage land information is evident at both state and national levels. The importance of information about the built environment held by local governments is increasingly recognized. Components of the framework are also emerging from a range of private sector interest groups and even community organizations. Table 1 provides a preliminary list of major state, federal, and peak national bodies already involved in developing a national framework for managing land information. These organizations and associated initiatives need incorporation into any new vision.

Table 1. Major Australian organizations already contributing to a national infrastructure for managing land information

Level	Organization
State and Territory Government Agencies	The Land and Property Management Authority, New South Wales Government
	Landgate, Western Australian Government
	Department of Sustainability and Environment (DSE), Victorian Government
	Planning and Land Authority, and the Office of Regulatory Services (Department of Justice and Community Safety), Australian Capital Territory Government
	Northern Territory Lands Group, Department of Planning and Infrastructure, Northern Territory Government
	Department of Environment and Resource Management, Queensland Government
	Land Services Group, Department of Transport, Energy and Infrastructure, South Australian Government
	Property, Titles and Maps Group, Department of Primary Industries, Parks, Water and Environment, Tasmanian Government
Federal Government Agencies	OSDM (Office of Spatial Data Management)
	ABS (Australian Bureau of Statistics)
	Centrelink
	ATO (Australian Tax Office)
	Australian Post
	CSIRO
	BoM (Bureau of Meteorology)
	GeoScience Australia
	DAFF (Department of Agriculture, Forests, and Fisheries)
	DCC (Department of Climate Change)
National Alliances and Related Projects	ANZLIC Australia New Zealand Land Information Council
	ICSM (Intergovernmental Committee on Surveying and Mapping)
	COAG (Council of Australian Governments)
	PLRA (Property Law Reform Alliance)

	NECS (National eConveyancing System)
	DAF (Development Assessment Forum)
	CRC-SI (Collaborative Research Centre for Spatial Information)
National	Australian Property Institute
Interest	Property Council of Australia
Groups	Real Estate Institute of Australia
	Australian Property Law Group (Law Council of Australia)
	Australian Institute of Conveyancers
	Australian Institute of Quantity Surveyors
	Royal Institute of Chartered Surveyors Oceania
	Australian College of Community Association Lawyers
	Facility Management Association of Australia
	Master Builders Association
	Shopping Centre Council of Australia
	Spatial Industries Business Association
	Urban Development Institute of Australia
National	PSMA Australia
Data	
Providers	

Australia's pragmatism in the face of complicated federalism has delivered solutions to the land information problems. PSMA Australia successfully produces national scale integrated information services. The most well known and appreciated is the Geocoded National Addressing System. G-NAF is special because it pioneered the connection between text information and geocodes to provide a multi-purpose tool capable of being used whenever a person or organization needed to use addresses. The product carried a high level of functional accuracy because it was built on the basis of cadastral parcels, and properties reflecting actual occupancy of land. This accuracy is functional, not precise, given precision in cadastral information in Australia is a remote (and arguable) goal.

Another major initiative that has the potential to impact on activities is the ANZLIC Spatial Marketplace. The marketplace is focusing on developing an infrastructure that is at once accessible to non-specialist users, is capable of supporting transactions between suppliers of data and users, and allows easy publishing, distribution and discovery of and access to spatial information. The marketplace must be able to support: finding and accessing spatial resources (data, products, services, processes), publishing and marketing these resources, and gathering of intelligence from the spatial market place to facilitate bringing together suppliers and users for the development of new spatial resources.

5.2 European Union initiatives

Similar efforts come from other federated states and the European Union. The INSPIRE initiative to create a European Union (EU) spatial data infrastructure was implemented by the European Union in 2007. The aim of INSPIRE is to enable the sharing of environmental spatial information among public sector organisations and better facilitate public access to spatial information across Europe. It with be implemented incrementally across 34 spatial data themes with full implementation scheduled for 2019.

5.3 United States Initiatives

In the United States private sector solutions to land information problems remain a popular approach. A plea for building a national cadastral database (a tool Australia already enjoys) is eloquently presented to the US Congress by in paper titled National Land Parcel Data: A Vision for the Future (National Academy of Sciences, 2007)

Meanwhile global initiatives undertaken by Google, Microsoft Maps, and Yahoo have popularized spatial information with the special capacity to integrate place or geocoded information with images and pictures, and even live videos. These systems are highly commercial and increasingly well organized and popular with users.

6. DETERMINING FUTURE RESEARCH DIRECTIONS

6.1 Furthering the Design Elements

Testing these design elements against emerging global initiatives reveals future research directions involved in designing a national infrastructure for managing land information (Table 2).

Table 2. Features of a National Infrastructure to Manage Land Information

Design Element	Future research direction	Comment
1. Shared Vision	Determine the vision in the Australian context.	Determination on whether the system delivers information management, transaction management or is simply service provider is required. Collaborative workshops between key stakeholders are required.
2. Common Language or Ontology	Investigate an ontological system to facilitate integration of Australian land information.	The development of nationally applicable ontologies is notoriously difficult. Significant advances are already evident in national addressing system. Tenures, valuations, development, and planning need work.
3. Governance framework	Determine policy, legal, and institutional configurations that work in a complex federation.	Various models for overcoming the rigidity of state legal and financial arrangements are used. The most successful to date is PSMA Australia.
4. Business case	Examine customer expectations and needs.	Delivery of outcomes needed by the various constituencies is essential.
5. Information requirements and data model	First, conduct a systematic examination of standards and uses of information. Second, investigate existing models in LandXML, Harmonized Data Model, and the Core Cadastral Domain data models	It will be necessary to clarify a series of issues about accuracy, reliability, precision, status as court evidence, and privacy protection. In relation to data models, significant work in data modeling for land administration already exists in Europe.
6. Technical infrastructure	Investigate applicability of existing and developing systems. (e.g. LYNX developed by PSMA, and Shared Land Information Platform (SLIP) of WA	A variety of technical options already exist. New web technologies however also offer opportunities for reconstruction of information. Leading innovators are South Korea and Singapore.
7. Implementation and maintenance models	Investigate costs and time requirements required to deliver system. Additionally, develop a robust maintenance regime.	Maintenance, capacity building, education, financial robustness will be essential considerations for any model to be an ongoing success.
8. International	Examine trends in leading nations	The Europeans continue to develop

compatibility	and international organizations. Additionally, examine the "Social Inclusion Agenda" and the "Seamless Economy" of federal administration, along with the spatial enablement of all levels of government	approaches for land administration including authoritative registers. In USA, the lack of a national cadastre is addressed by private sector innovation in web-based land information systems. PSMA Australia's signing with Euro Geographics a memorandum of understanding to collaborate, cooperate and exchange information is further evidence of international collaboration.

These design elements in Table 2 appear onerous. However, Australia already has a firm foundation upon which to build. Numerous initiatives provide attractive opportunities for agencies to use and contribute to sharing platforms (e.g. SLIP, PSMA Australia's model). Additionally, within the spatial sector, spatial capacity and geocoding are seen as a means of ensuring with on-ground functional "truth". Also, reorganization of information processes and, more recently, business processes by using geocoding and the visualization of information is occurring.

Vital, but largely unacknowledged contributors to these successes, are the land registries of Australia. Thus far land registries have concentrated on conservative management of private land information to deliver security of tenure for marketable commodities in highly active land markets. The performance of this role changed dramatically with the introduction of standard technologies that permitted acquisition of much more data, interoperability of data, quarantining of specific information to ensure privacy, and public access to information. The next generation of developments of registry roles will be pushed by spatial enablement of government overall and increasing nationalization of land information.

6.2 The role of research institutions

Research is essential to overcome limitations of vision and management restraints found in agencies and to negotiate with international colleagues who share similar journeys. Any research approach must be also neutral in terms of preferred technical solutions and capable of assessing a range of solutions.

The Centre for SDI and Land Administration at The University of Melbourne designs new solutions that can predict the future, merge within the global trends, build on existing capacity, and change paradigms of operation of agencies and businesses. It is an ideal research model to develop the national land information infrastructure (cf. Williamson *et al*, 2010).

7. CONCLUSION

Land information now assumes far more significance that it did in the comparatively simple times of 19th and 20th centuries when it was collected and maintained in silo agencies. Land information must now be shared across agencies and throughout a nation to enable the delivery of spatially enabled societies. The challenge to land registries are not new: in all the democracies, these agencies are being asked to accept radical change in order to meet social and economic needs. Many nations, including Australia are seeking solutions. Many international initiatives attempt to use and integrate information sets generated by land administration activities. These initiatives are worthwhile in themselves but they remain limited.

The national infrastructure to manage land information is in its early days. Agencies that hold key land information are now driving efforts to define a new

paradigm in land information management that can take Australia to the forefront in the search for an infrastructure. A great deal of effort will be required to engage the broad base of stakeholders who have needs that must be met. A shared vision and common language will be essential elements. A governance framework and business model that enables the cooperation of existing players must also be encouraged so that the successes of pragmatic relationship building are enhanced. Information requirements, data models, technical standards, and maintenance models all require further assessment and development as does the longer term requirement for international interoperability. If these design elements can be further developed they will set the stage for new roles for land registers as the key players in national land management and delivery of sustainable development and good governance.

8.   ACKNOWLEDGEMENTS

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