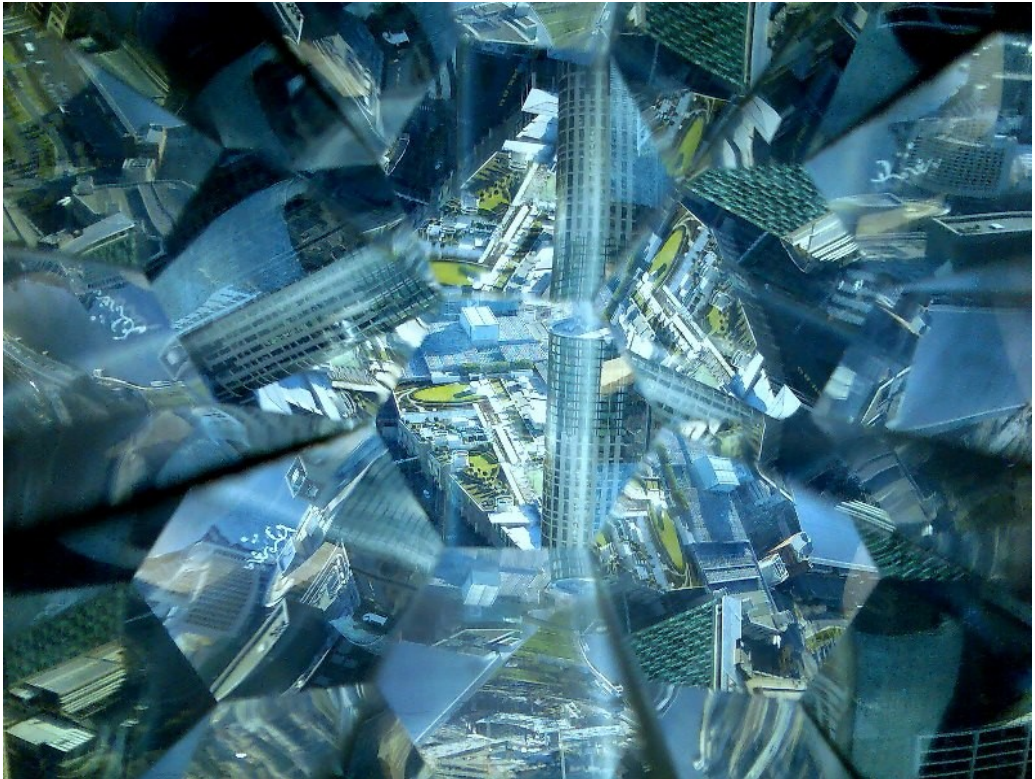


RESEARCH SNAPSHOT

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A National Infrastructure for Managing Land Information



Editors

Abbas Rajabifard, Ian Williamson and Mohsen Kalantari



MELBOURNE
SCHOOL OF
ENGINEERING



A National Infrastructure for Managing Land Information

Research Snapshot

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Abbas Rajabifard, Ian Williamson and
Mohsen Kalantari

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Contact

Professor Abbas Rajabifard

Email: abbas.r@unimelb.edu.au

Centre for Spatial Infrastructures and Land Administration

Department of Infrastructure Engineering

The University of Melbourne

Victoria, 3010, Australia

Telephone: +61 3 8344 0234

www.csdila.unimelb.edu.au

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Executive Summary

National Infrastructure for Managing Land Information (NIMLI) is an Australian Research Council Linkage project (ARC-Linkage) designed to assist Australian state land administration agencies in endeavours to take national approaches to management of land information for sustainable development.

Historically Australia's land administration systems have evolved to a point in which each jurisdiction has independently computerised its processes, according to its own timetable, needs, reporting functions, customer service design and other imperatives. Consequently, national priorities that rely on information about land are faced with the technical, policy and institutional barriers that come with integrating data from multiple state-based sources. As a federation of states, each state and territory has its own system of land administration that has served the nation well. However, their capacity to meet Australia's increasingly national drivers such as climate change, disaster management and recovery, national business coordination and national security, is challenging.

A research team within The Centre for Spatial Data Infrastructures and Land Administration (CSDILA), at the University of Melbourne through the NIMLI ARC-Linkage project (2009–2012) in collaboration with PSMA Australia Limited; Land Victoria (Government of Victoria); Landgate, (Government of Western Australia); Land and Property Information (Government of New South Wales); investigated drivers and components to facilitate and support the design for a new infrastructure to integrate the jurisdiction-based land information and administration processes within the country. This booklet is a snapshot of the outcomes that have arisen from the NIMLI project and land-related research. A comprehensive list of publications derived from this project and other related research can be seen at the end of this booklet and accessed on the CSDILA website (www.csdila.unimelb.edu.au).

The project delivers both technical and non-technical options to justify and assist national integration of data held in diverse models and organisations. The project argues that the strategic planning of capital cities, e.g. levying of capital gains tax, allocation of drought relief, management of crime and terrorism, development of early warning systems for emergencies and climate change initiatives, all require seamless information about land ownership, use, value and development.

The outcomes of the project demonstrate that the large federal departments and agencies (the Australian Taxation Office, Centrelink, Reserve Bank of Australia, Medicare and others) all need national land information, as do national businesses and their representative groups. These include the Property Council of Australia, the Law Council of Australia and the major mortgage providers.

The project has also added clarity to the importance and content of land information generated by the state and territory land administration agencies by developing the concept of AAA rated land information (that is Accurate, Assured and Authoritative). Importantly, AAA land information has a documented and legally valid audit trail that is the key to good land governance and information management.

Further, the project argues for the need for seamless access to spatially referenced land information from multiple databases across the country that link all sectors to the providers and users of spatial information. The research further demonstrates a significant demand for a 3D land and property information platform to support a national infrastructure for land information.

In response to this, the Centre also coordinates another ARC-Linkage project on Land and Property Information in 3D in collaboration with the Intergovernmental Committee on Surveying and Mapping (ICSM), Land Victoria, Land and Property Information NSW, PSMA Australia Limited, VEKTA Australia, Fender Katsalidis Architects, Alexander Symonds and Strata Community Victoria.

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We would also like to acknowledge and thank Dr Rohan Bennett, who was Research Fellow in the first two years of the NIMLI project and continues his interest and involvement in selected components of the research.

The editors would also like to extend their special thanks to the School of Engineering and the Department of Infrastructure Engineering for their support, as well as the research team, in particular Ms Jude Wallace, at the Centre for Spatial Infrastructures and Land Administration, for their continued hard-work and dedication to this project and associated research.

Chapter 1: Introduction

Abbas Rajabifard and Ian Williamson

Designing a National Infrastructure to Manage Land Information

Australia's land administration agencies focus on state and territory processes. They should be able to provide the integrated information needed by policy makers, business and community stakeholders required to serve modern and complex markets and resources management, which increasingly require a national focus. This has resulted in the need for an infrastructure to nationally integrate disparate, state-based land information and administration processes to meet national needs. The NIMLI project addresses these needs.

The need for a national framework to manage land administration that is evident at both national and state levels can be assisted by Australia's strong track-record in the integration of information. Due to the importance of information about built environment, this local level of government also needs to be integrated within the national framework. In addition, a range of private sector interest groups and even community organisations should also play a role within the national framework.

This chapter is an introduction to the land-related research projects of the Centre for SDIs and Land Administration. The chapter introduces the composition of different elements and major outcomes and drivers, applications and demonstrators of the research projects. In particular, the chapter summarises a snapshot of the publications delivered through these projects.

Identification of the National Drivers

As part of the (NIMLI) project and the result of an intensive international study by the Centre on the drivers for a national land information infrastructure, Bennett et al., (2012) show that the national drivers are complex and change frequently, generally due to political, scientific and environmental debates raising policy issues. This study has suggested the drivers can be classified into the following categories and as shown in Figure 1:

- economic management
- environmental management (built and natural)
- social management
- harmonised governance
- technological possibilities.



Figure 1. National Drivers for an Infrastructure to Manage Land Information

Economic Management

Land generally 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 (Bennett, 2012). 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 for example, 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 recognised 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 in 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 usually struggle with the jurisdiction-based laws and processes in a market, that is increasingly national in focus. At the macro-economic level, organisations such as the Reserve Bank of Australia (RBA), in any jurisdiction require national property information to make informed decisions about national monetary policy. Currently, authoritative land transaction and ownership information in Australia, for example, 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. 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.

Countries who have 'unbundled' interests in land and resources, are enjoying multiple markets in complex commodities related to land (Wallace and Williamson, 2006). In this context, the 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.

Natural and Built Environmental Management

Environmental management also requires access to national datasets: the natural environment does not respect state or local borders. Effective management of cross-border situations increasingly requires access to national land data sets.

Drought relief provides another example. For 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 in 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 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 locations of farms are within the exceptional circumstances drought declared areas. In the past, these inadequate arrangements led to difficulties in the validation of claims and identification of fraudulent claims.

Drought relief examples bring into focus the broader case of disaster management. Many 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. 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 landowners, 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).

Social Management

Governing the activities of people and communities requires access to land information on a national scale: land information allows people, communities, and their activities to be linked. Responding to organised crime on a national level and allocating welfare and relief-funding, demand such an approach.

Law enforcement and emergency management are national activities. However, 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 local, state and national 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 national 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.

Harmonised Governance

Good governance is often described as the fourth pillar of sustainable development. Increasingly, harmonised governance is seen as being an important part in delivering good governance. Harmonised 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 harmonise the governance systems of different levels of jurisdictions in line with national governments is always recognised by most stakeholders. Harmonisation can save millions of dollars and radically improve the ability of businesses, communities and governments to operate on a national level. Meanwhile, private sector frustrations about inadequate and out-of-date arrangements

continue to grow. The national umbrella organisations all see benefits in more timely and seamless spatial and land information.

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 organised according to its impact on a place.

Global technology companies such as Google and Microsoft are the popular players in this paradigm shift. Google's easily accessible Web 2.0 friendly web-mapping platforms have commoditised once complex and expensive GIS processes. Additionally, freely available high-resolution imagery and 3D visualisation tools have demonstrated the power of spatial information. Users of government information systems increasingly demand this level of visualisation and functionality.

The contemporary information revolution is not only about merging phones and computers. The commoditisation of spatial information management platforms allows SDI practitioners to move their focus from organising spatial information to *spatial organisation 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.

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 according to the study by the CSDILA research team as reported by (Bennett et al., 2012) and illustrated in Figure 2.

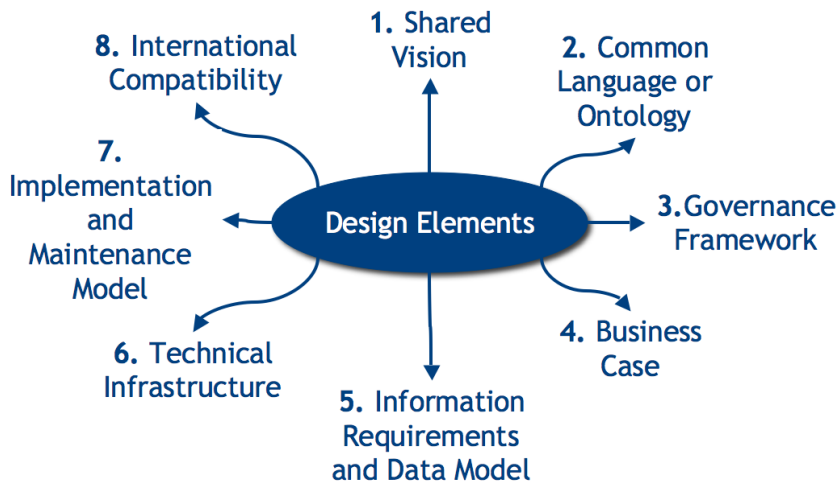


Figure 2. Design Element for a National Infrastructure to Manage Land Information (Bennett et al., 2012)

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 national-based systems using a single point of entry and streamlined, single electronic data entry building on national electronic conveyancing ideas for example. 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. 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.

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 (Bennett et al., 2012). 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.

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

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 of 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, it also needs analysis. This applies to institutional arrangements, should a new framework attempt to reorganise the functions of entrenched land administration agencies. The preferred relationship between the three levels of government, peak national bodies, and the private sector needs to be determined, as does the role of public/private partnerships.

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.

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.

A data model is also required, that is a harmonised Data Model, in order to standardise land-related datasets. However, the applicability of the Harmonised 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.

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 (Kalantari, 2009), and 3D visualisation 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.

Implementation and Maintenance Models

A plan for implementation identifying costs involved and timelines needs to be articulated. 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.

International Compatibility

Designers of a framework for integrating national land information must look beyond jurisdictional 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.

Organisations Consulted for Research

NIMLI maintained watch over all land information related initiatives in the development of uniform property law, Spatial Data Infrastructure, Volunteered Geographic Information, Productivity Commission, and other policy makers, and international initiatives in Europe especially. However, extensive consultation has been with staff from a wide range of organisation at the federal, state and local levels, as listed below:

- ANZLIC
- PSMA Australia Limited
- MDBA
- Office of Spatial Policy
- Australian Taxation Office
- Grattan Institute
- Reserve Bank of Australia
- Australian Urban Research Infrastructure Network
- Major City Unit
- Department of FaHCSIA
- Dept of Sustainability, Environment, Water, Population & Community
- Department of Sustainability and Environmental, Land Victoria (Land Registration Services, Office of Valuer General)
- Department of Planning and Community Development
- VicRoads
- Municipal Association of Victoria
- Several local councils in Victoria
- Land Property Information NSW
- Landgate, WA

Finding 1: Disparate Land Information in Australia

Investigation on the effectiveness of land data structure and data flow was a critical path in undertaking the project. NIMLI took the widest scope of 'land information' into its project to identify opportunities for its better management throughout all levels of government.

Integrated land use and land development datasets (Development Assessment processes) was identified critical to aid the future Strategic Planning of Capital Cities in Australia. Current arrangements with land-use and land-development data, does not provide an effective foundation for strategic planning at the national level. This is imperative to accommodate integration across functions, including land use and transport planning, economic and infrastructure development, environmental assessment and urban development. In particular to ensure Australian cities are globally competitive, productive, sustainable, liveable and socially inclusive and are well placed to meet future challenges (climate change) and growth.

It has been identified that there are inadequate dynamic flows of authoritative information about market transactions (tenure and value) between the state land agencies and federal macroeconomic policy makers. As such there is an information asymmetry between the government collectors and users of land information.

It has been identified that land information regarding risk of: riverine flooding, bushfire, earthquake, severe weather (storm wind gusts, lightning, hail, thunderstorms, intense low pressure systems, tornados, heavy rainfall, flash flooding, blizzards, heat waves etc.), cyclone (includes gale force winds and storm surge), tsunami, landslide, sea level rise, other fire related incidents (house fire), fraud, drought, disease outbreak, asbestos, and pests (white ants, locusts, fruit fly etc.) need to be properly structured to serve decision-making processes at the national level.

Finding 2: Institutional Arrangements

In addition to current arrangements by which land information is collected and managed, institutional arrangements have been identified as a major factor in achieving an infrastructure to disseminate land information for national needs. The concept of a seamless national economy, as outlined in the COAG partnership agreement in 2008, certainly demonstrated that there was an increased focus on a national approach on many fronts. There are several areas that relate to land information including the national

electronic land conveyancing and the planning strategy. The establishment of the national personal property security register also provided some messages for the national land information infrastructure in that the COAG involvement brought about its successful delivery after decades of minimal success. Urban Housing has been identified as a key area by the AURIN Management Board and approved by DIISR as being of national significance.

At the national level, there has been minimal effort to coordinate or define the Commonwealth's requirement for land information until recently. Whilst in the past there has been little interest from the federal government agencies except for ABS, ATO and the RBA, increasingly many other agencies are seeking this information to support their various activities. The sourcing of this information by the various departments is generally done in isolation of other departments. However, PSMA Australia has played a significant role in building national spatial datasets; however, these have been limited to Cadlite, addresses and road centrelines. Other key datasets identified as disparate in the previous section, such as land use, land development / planning, have not been produced yet.

It has been argued that the land information, which is the subject of this research, is essentially generated and maintained at state and territory level. However, it was observed that the role of local government in generating this information is also significant. Much of the land information (such as address) is generated as an outcome of land-development processes, which are regulated at the local government level.

In establishing a national infrastructure for land information, there are considerable lessons to be learnt from the manner in which PSMA Australia and NECDL (i.e. National Electronic Conveyancing System) have been established and the collaborative efforts to bring about national information related to land administration. For instance, funding derived from the licensing of information is critical to the ongoing maintenance of data in most of the jurisdictions. The recent Lawrence report prepared on behalf of the Federal Government highlighted many of the issues facing the development of a national land information infrastructure, not the least being the lack of funding available to build and maintain national land information. Also it was argued that the public does not sufficiently have access to appropriate data that will allow them to make meaningful contributions to decision making.

Although there have been difficulties in assembling datasets due to different data formats, significant issues were identified with regard to the willingness of agencies to release data. Issues of confidentiality and privacy and particularly funding/pricing model and inconsistent land-administration processes are major challenges.

Project Outcomes and Products

The project has discovered issues and challenges that impede achieving a national infrastructure for managing land information. To address these issues and provide solutions to the challenges, the project is offering the following options, concepts and a tool to facilitate realising the national infrastructure:

AAA Classification

Accurate Assured Authoritative (AAA) qualities of land information generated in land tenure, value, use and development differentiate this land information from all other kinds, and define its status vital for all functions of government. This is an important message to be communicated with government officials. However, issues here are the streamlining of the vertical integration of use patterns among the three levels of government.

Attribute Organisation

Owner, parcel, interest and transaction (OPIT) information in text or attribute format generated through registration processes has AAA qualities. However, OPIT is required to be spatially enabled. The NIMLI project has identified barriers to its use and advantages of improved availability.

Data Integration Parameters

The following 16 parameters were identified as critical for land information integration to achieve a national infrastructure. An Integration model was developed to demonstrate the outcomes:

- I). data creation: collection format
- II). data coordination and information flow
- III). storage and Maintenance of data
- IV). technology and technical issues
- V). data services funding/pricing model
- VI). spatial datasets dissemination and use

- VII). economic considerations
- VIII). environmental considerations
- IX). social considerations
- X). communication between agencies
- XI). public participation
- XII). organisational structure
- XIII). commitments and responsibility
- XIV). resources of the agencies
- XV). dispute resolutions
- XVI). capacity building.

Benefits of NIMLI for State's Land Administration Systems

As it has been highlighted, most of the outcomes from NIMLI relate to the aggregation of jurisdictional state data and there are important lessons to be learnt that are relevant at this level.

Key lessons for the jurisdictional systems relate to the lack of consistency between the systems with regards to terminology (i.e. absence of any standards). Whilst harmonised data models exist in some cases as a general rule each jurisdiction has to translate their data into the model rather than modify their approach to the capture and storage of the data. In reality there has been no incentive to bring this about, as there are no benefits for the jurisdictions in doing so.

The other key lesson is the interest in timely data. Increasingly having data that is three months out of date is considered less than acceptable. Users are seeking current data. This may necessitate the manner in which the jurisdictions' aggregate data from local government and once again bring about increased costs to the jurisdictions with minimal benefit to them.

Also another lesson is that the jurisdictions should be collectively pushing the Commonwealth Government to set out its requirements for land information in a clear definitive manner. The current approach of each Commonwealth agency pursuing its own needs retards any move towards a standardised national approach. Whilst it is recognised, ANZLIC now appears to be pursuing this goal and it is unknown as to how detailed this will be and if it will be representative of all the Commonwealth agencies' requirements. The question remains however, what incentives will be provided to the jurisdictions to bring their data towards a standardised approach.

Structure of this Booklet

This booklet provides a detailed discussion supporting the findings, products and future direction in relation to a national infrastructure for managing land information. Chapter 2 sets the scene for such an infrastructure. The chapter explains different types of land information and its classification. The chapter argues Australia's land information is a national asset, but it is neither well known nor used as widely as it should be. Chapter 3 argues that the resolution to leverage off land information can only be achieved by the implementation of a national land information infrastructure through a collaborative effort between all the governments of Australia. Chapters 4, 5 and 6 present case studies to support the realisation of the national infrastructure. Chapter 4 presents the interrelationship across land administration functions (land tenure/registration, land value, land use and land development) and between different levels of government in the management and delivery of land for housing production at the national level.

Chapter 5 draws on principles from natural capitalism, to design a land market information flow lifecycle to establish an operational link between land administration agencies and central macroeconomic policy departments, in federated market economies. Chapter 6 looks at the issue of land information from a risk management perspective in understanding how land administration systems and agencies need to change their contributions to the management of risks affecting land and property.

For a future research direction, the rest of the booklet puts emphasis on the importance of 3D land information, as well as accessibility and discoverability of the information. Chapter 7 provides an understanding of the institutional infrastructure required to support a shift towards a three-dimensional paradigm in managing information regarding rights, restrictions and responsibilities associated with land and property. Chapter 8 provides some examples of three-dimensional modelling and its application in urban planning, disaster management, asset management, environmental monitoring, navigation and intelligent transport systems.

Technically, chapter 9 illustrates the challenges involved in representing 3D land information. Chapter 10 highlights the emergence and importance of Building Information Modelling as part of the national land information infrastructure in our country at its different levels to facilitate land management and the support of sustainable development. Chapter 11 illustrates the main difference between the Australian jurisdictions in

cadastral data modelling, and calls for a uniform national data model. Chapter 12 introduces new dimensions to facilitate sharing the information within the national land information lifecycle and the need to provide and maintain complete, up-to-date, and precise metadata for shareable land-related datasets. Finally, Chapter 13 presents the development of an integrated land information platform along with four demonstrator projects that cover the most pressing issues facing the North West region of Melbourne: walkability, employment clustering, and housing affordability and health services.

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Chapter 2: Setting the Scene for NIMLI

Jude Wallace

Introduction

Australia’s land information is a national asset, but it is neither well known nor used as widely as it should be. Information about land comes from a variety of sources, supported by different software and applications. For the purposes of this chapter, it is necessary to differentiate three general categories: land information, spatial information and volunteered geographic information.

Land Information

Information generated by processes associated with land administration functions of land tenure, land value, land use and land development – fundamentally parcel and owner information and associated plans. The digital versions of this information are managed according to the technology used by the various agencies: Table 1 below.

Table 1. Basic land information functions in tiers of government in Australia		
Number	Tier of government	Principal land information functions
One	National Top tier	Data collection on a national scale for management of the economy, taxation, international obligations and other arrangements conferred by the Constitution and its subsequent interpretation on the Australian government
Eight	State and territory Mid tier	Land information management from land administration functions of tenure and value
565	Local government areas Bottom tier	Land information management for building and development and land-use planning

Spatial Information

Most major software systems are location-enabled so they can identify the place of something according to its XY coordinates and use location information to embellish functions. Geographic information systems (GIS) reveal relativities and relationships of a place. A spatial data infrastructure (SDI) is used to facilitate combinations of data sets while retaining the scalability, visualisation and interoperability essential to users. These variously contribute to spatial enablement of a system or a service, not merely information.

The pace of change is increasing with the cycle of technical obsolescence running fast. While land information languished in the quiet areas of public services, spatial information systems grew exponentially as governments moved increasingly into web services, especially using GIS and web-mapping services. This parallels the extensive increase in digital capacity since 1990. Point clouds, advanced 3D spatial analyses, cloud and tree-penetrating cameras, and other systems are now commonplace, technical advances. Other drivers are the lowering of costs of aerial photography, satellite images and orthophotography (correction of images to remove distortions caused by tilt, curvature and ground relief, and scaling corrections to record features in exact positions). Seamless and scalable data that the world now uses on a daily basis changed expectations about management of spatial information. Radio-frequency IDs, GPS, GNSS, WiFi and other facilities can track people, vehicles and goods. Every valuable item can have a sensor. Every person can carry two or three devices that are location-enabled (phones, cameras, computers, and increasingly ubiquitous data pads) while travelling in location-enabled vehicles.

Volunteered Geographic Information (VGI):

Crowd-sourced, geo-referenced information about events, people and the Earth's surface provided to websites. It is of-the-moment, but usually lacks a provenance that makes it reliable.

Boundaries among these categories overlap, and their characteristics vary according to the histories and practices of systems. A plethora of approaches is the Australian reality. Spatial information gained the ascendancy of attention after 1995, and sits behind the major initiative in data collection and access. VGI is slowly transforming from the disorganised and noisy to organised and useful (Goodchild and Li 2012).

Among these changes, this chapter seeks to position land information, particularly information generated by Australia's land registries, in national

land information policy and use. Processes in the registries and similar agencies responsible for land administration functions of land tenure, value, use and development generate information of quality, making it superior to any other information in a national collection. We call this quality AAA, explained in Figure 1 below. Each jurisdiction will extend AAA qualities to a particular data set as needs arise.

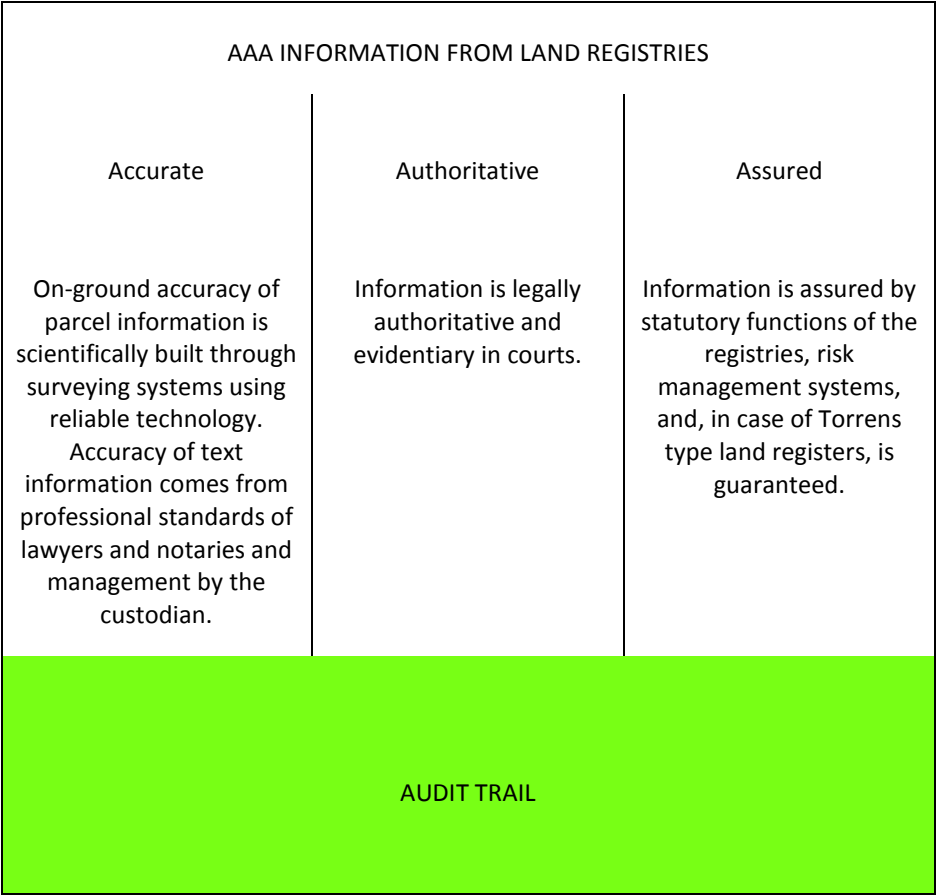


Figure 1. AAA qualities of land information

AAA registry information around the globe is of two kinds: the text information about owners and their arrangements, and parcel information. Most countries, including Australian jurisdictions, still use separate platforms and processes to handle each kind of information. In any event, the recording of transactions and the building of a map of boundaries of parcels are different processes, and vary among jurisdictions, even in Australia.

AAA Information about Owners and Parcels

Owner information is not information about physical things and conditions, that is, the kind of information typically supported by GIS. It is about rights, restrictions and responsibilities (RRRs). Rights are the familiar territory of land markets, ownership and tenures and gain their strength when strangers to the rights (including the government) are required to respect them. Rights are therefore conceptually related to duties owed to an owner by everyone else. Management of land rights in Australia is taken for granted. However, most countries of the world struggle to provide security of tenure. Restrictions are a growth area as governments increase regulatory frameworks to meet the imperatives of climate change, comfortable neighbourhoods, funding for essential services and more. Australian laws place hundreds of restrictions on land activities and uses. Restrictions can be seen as duties owed by a landowner to civil society and government managed by multiple regulating agencies. Responsibilities are vaguer: they are familiar to those who live in condominium titles, where use of an apartment must be proscribed by considerations of mutuality. Broad stewardship responsibilities associated with land ownership are much more specific in Europe than in Australia; in Germany a natural law responsibility of the owner for protection of ecological qualities of the land is recognised, and is evident in Art 14(2) of the German Constitution and cases interpreting it. These responsibilities extend to inter-generational qualities, such as the remediation of industrial contamination through past use of land (Raff 2003).

Historically, management of information about rights developed to meet narrow operations of the property market. Reliable management underpins robust concepts of property that distribute possession of land and resources and provide security for loans. Land information precisely defines the legal objects of ownership and opportunities associated with them. Countries that manage their information about rights in ways that attract public confidence enjoy advantages of wealth generation (Wallace and Williamson 2011). By contrast, information about restrictions and responsibilities is poorly managed, although it is essential for implementation of planning standards, environmental protection, building quality control, contamination removal, taxation compliance and so on.

AAA qualities of text information held in datasets are evident in information about owners, parcels, interests and transactions (OPIT) in Figure 2 below produced by Australian land registries. A proportion of the information is not generated by transactions, but by court and

administrative decisions, bankruptcies and corporate liquidations and work-outs, and social transitions on marriage, death and loss of capacity. The registries collect all these changes in land interests, as well as the transactions of mortgage, discharge, lease, sublease (variously among the states and territories) and other commercial dealings. They variously record covenants, easements and profits a pendre. Each of the eight Torrens systems operating in Australian registries achieve global best practice in land registration and offer simple searches, guaranteed titles, and cheap transactions. Their digital systems manage registration processes successfully but are not spatially enabled or capable of producing interoperable RRR information to the extent these are registered.

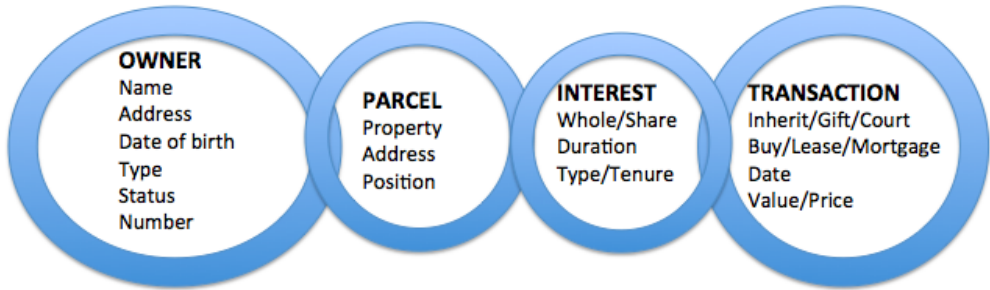


Figure 2. Owner, parcel, interest and transaction information

Variations among the Torrens systems in the eight jurisdictions attract arguments for a uniform national Torrens law in the belief that legal uniformity will reduce costs of doing business. A draft uniform Torrens Title Act was produced by property interests (Property Law Reform Alliance, 2011). Given the difficulties of achieving national parity among embedded property systems, illustrated by efforts over twenty years to achieve a national personal property securities law, other non-legal opportunities for parity in registration practices and common administrative forms and processes remain appealing. Among these opportunities, the national electronic conveyancing system (NECDL) will achieve commonalities that significantly reduce business costs and variations of practice. NECDL will also produce OPIT digital information on a national scale (when fully operational), potentially Australia's most valuable AAA land transaction information. NECDL is therefore a first and necessary step in retrieving the value inherent in OPIT information.

Checks of identities of people and legal entities who apply for registration are not undertaken with the same rigour as, say, in The Netherlands or

Germany where citizens must produce evidence of citizenship and identity in order to register. The witness provisions in Victoria are among the most basic identity checks in land transaction practice, but are now accompanied by proofs of identity during collection of stamp duties. Identity protection is reinforced by security systems in registration processes and criminal and civil laws dealing with fraud and forgery that are, by and large, effective. Identity fraud is rare in Australia. Moreover, NECDL will assist identification because identify confusion and theft must be controlled for a digital conveyancing system to attract public confidence.

During the 1980s and 1990s the registries changed paper systems to digital systems. Mostly, the IT services were built to deliver registration, not information, services. These computer systems are difficult to upgrade to current standards of data interoperability, visualisation and spatial enablement. Computerisation of registration functions delivers copies of a title (folio) from a digital file, which includes text information and copies of the title plan. There is no national file of OPIT information.

Ideally, OPIT and other land information should be spatially enabled in the sense that it is available on the web, seamlessly integrated throughout the nation, geocoded and searchable through a scalable, map-based facility, overlaid on visual images, and capable of servicing multiple attributes detailing RRRs created by agencies within and beyond the registries. The web service also needs to integrate information to permit aggregated queries, such as ‘all the land parcels in New South Wales that benefit from licences to access crown land and mixed database queries, such as ‘all the land in Collingwood owned by non-rateable entities’ (combining registry and ratepayer datasets). The query functions can be rationed according to scale, privacy, and commercial and licensing imperatives so that some queries are publicly accessible and other queries restricted to authorised entities.

AAA Information about Parcel Boundaries

A map or diagram of the boundaries of a parcel produced by a surveyor is spatial information. If the surveyor uses a computer to undertake survey calculation and other tasks, the digital information is spatial data. The cadastral data file, often called a digital cadastral database (DCDB), or similar name, therefore has unique qualities.

Over time, surveying standards and equipment have improved, so that reinstatement of marks and boundaries according to high levels of accuracy is now commonplace. Integration of new tools, including GPS based

measurements and calculations, is negotiated according to their ability to achieve confidence levels.

Developed countries institutionalise the survey system by laying markers at levels to re-establish points and lines on the map. The scientific methods used to ground truth the parcel map help to match physical boundaries and the data about the boundaries to rigorously reflect the scale, boundary position, area and measurements of a parcel of land. This matching must not be confused with accuracy or legal certainty. In Torrens systems, boundaries, areas and relationships among parcels are not legally guaranteed, and need not be.

Early attempts at parcel mapping used drawings on rock, then clay, papyrus and even stone (Bavaria), before the familiar parchment and paper arrived. Paper maps were kept at various large scales so that a small village could be represented on an accessible and functional-sized sheet, but a regional area map would be a smaller scale permitting greater coverage on a similar-sized sheet. This history in part is accounted for by divergent development of two professional groups: the surveyors who managed parcels of land; and the 'mappers' who reflect features of land in general. This distinction remains today: the science of mapping is different from surveying; but both mappers and surveyors make maps as part of their professional activities and the distinctions fade in new technologies.

History remains important, however. Survey maps are specialised products; even more so when they are digitised. Two approaches are generally used to convert paper maps of parcels into digital information; the first involves conversion of paper maps into equivalent digital maps. When this is undertaken, issues about accuracy are often revealed that require information to be adjusted to achieve a 'best fit'. The second involves accumulation of information from new subdivision and survey activities that are undertaken with modern technical equipment. These modern surveys create digital information on the fly that is remarkably accurate across various scales. Most DCDBs amalgamate data from these and other different processes. A DCDB on a national scale is always under construction and constantly improved according to technology and the pace of land development. The digital map is therefore functional, and is built in three distinct environments, (Figure 3 below), each with its own processes, accuracy checks and histories.



Figure 3. The three distinct environments of parcel information (Bennett et al. 2010)

The Parcel Map as AAA Land Information

Compared to other spatial information, data obtained from surveying has unique features relating to how the data is created and the functions it services. When digitised, cadastral information files to some extent carry forward these unique features into virtual or digital environment.

Scientific Standards

Cadastral systems identify coordinates by using surveying techniques and an established coordinate system. Developed countries use a single geodetic standard, such the GDA94 used in Australia.

Scale

Cadastral information is about land parcels that reflect the way people use their land. Parcels define the homes, workplaces, and facilities and connections between them. This people scale is the most important feature of the cadastral fabric. On the technical level the fabric is large scale. That is, it represents large areas on-ground. Useful scales for cadastral data are 1:500 for urban areas and 1:2500 or for non-urban areas.

Legally Authoritative

Civil society requires land allocation systems and boundary definitions that are acceptable according to the social norms and land-use practices within communities. For settled societies, boundary identification is typically a legal function. The activities of surveyors and their surveys produce authoritative information about land boundaries. Likewise most other land information kept by governments, including a comprehensive register of changes in private interests in land, is also legally significant and sometimes determinative. Legal status is an outstanding feature of cadastral information. The survey is legally significant in the hierarchy of evidence used to prove boundaries, even though in most systems other information can be more determinative: for example monuments and intention. The DCDB, by contrast, is neither legally authoritative nor determinative in most countries.

Dynamism and Change

Cadastral information at one extreme is stable and unchanged: many parcels remain untouched for generations. At the other extreme parcel configurations change rapidly as population movements demand high-density infills for urban renewal and conversions of outlying peri-urban and agricultural land to housing. These man-made changes introduce a high level of plasticity into the cadastral fabric.

Dramatic changes to boundaries of many parcel also result from natural disasters such as tsunamis and earthquakes, sometimes on the terrible scale of Japan's tsunami of 11 March 2011, and Aceh's tsunami of 26 December 2004. River changes and coastal deformation also force boundary changes.

Professional Responsibility

The cadastral layer is built by professionals who are usually licensed by the government, and subject to quality assurance and quality control systems, monitoring, and exclusion from the profession in cases of failure or neglect.

Support for High Value Land Information Services

In Australia the parcel map is the most reliable and consistently updated national information and is appropriate for government and business use.

National digital Parcel Map

The computerisation of the parcel maps into a digital database at jurisdiction level was also achieved, but different systems, ontologies (e.g. roads and features) and maintenance programs impede national coherence. The states are variously absorbing the new GPS technologies into surveying methods as accuracy of readings improves. Survey laws and practices also vary. Victoria, for instance, uses adverse possession of whole and part parcels to keep title and actual boundaries aligned. The boundary system is relatively imprecise especially for old parcels. New South Wales aligns parcel and title boundaries through encroachment legislation. Accuracy levels also vary as the states utilise the standards set by the Inter-Governmental Committee of Survey and Mapping (ICSM) and Standards Australia. Western Australia has achieved nearly state-wide survey accurate cadastral map (SACM), and Tasmania has established a survey project to deliver accuracy in its digital cadastral database. Other states would require a convincing business case to resurvey parcels and build the associated map rather than improve accuracy over time by integrating new accurate surveys into the system (ICSM 2003). A Victorian business case was presented in October 2012.

Over time, the digital cadastral parcel files were coordinated into a national dataset through the cooperation of mid-tier government agencies and PSMA. The national file, CadLite, is a commercially available product. Take up of CadLite as a product is increasing. Building footprints are not included, though best practice standards for a modern parcel map would include them as a matter of course. CadLite can be overlaid on other spatial information and, until 2011, was used by Google Maps.

Addressing Systems and Address Information

Australia's addressing systems are successfully established, and undergoing further improvement. A digital version of addresses is the national geocoded national address file (GNAF), another product of PSMA. The address data includes geocodes, with adjustments to account for addresses of properties where these are different from parcels. Geocoding reflects local practices in use of centroids and multiple points in the digital mapping fabric and histories of data collection in the eight jurisdictions.

At state levels, the maturity of the addressing systems vary. GNAF undergoes continuous improvement to eliminate and explain the diversity of buildings, parcels and properties and their relationships over time.

Overall empirical checking of the addresses refines multiple references to a single place.

Differences between Parcels and Properties

Parcel maps and property addresses are inevitably different. Parcels are discrete areas of land designated in a title, separately owned and capable of independent sale. Properties are the various arrays of parcels and developments within parcels that suit a business, agricultural or other configuration. Registries work with parcels. The world works with properties. The two datasets are not equivalent: about 10–15% divergence is estimated. The world often puts many useable properties within one parcel, e.g. a typical office block owned by a single owner and rented to many tenants. A property can also consist of a number of parcels. In agricultural uses these need not even be contiguous. The problem of relating parcel and property maps is additionally complicated by local building laws and practices. In some states, such as Victoria, a building cannot traverse a parcel boundary and set-back requirements are routinely enforced. Addressing systems must therefore reflect the variations among the states, the history of creating formal addresses, and the diverse practices in local government areas that generate new formal addresses.

A map of properties rather than parcels offers functionality for many users and is under construction. The property spatial view was released by PSMA in August 2012.

Towards a National Land Information System

In accordance to the above discussion, two major trends are evident:

- Management of restrictions and responsibilities by states and territories
- Growth in demand for land information by national agencies.

Management of restrictions and responsibilities by states and territories

The growth in statutory restrictions that relate to land is documented (Bennett, Wallace and Williamson 2008). Disclosure of these restrictions was originally mandated in order to provide consumer protection, not land information management. Governments responded to perceived needs of buyers, mortgagees, lessees and developers for transaction-based information that related to specific parcels. The approaches varied. Western Australia, Queensland and New South Wales use a centralised land information approach to streamline the enquiries. Others built enquiry

systems to either indicate properties affected or potentially affected by a restriction (South Australia and Tasmania) or to allow web enquiries determined by intending vendors and buyers. Victoria's system relies on web or mail applications to custodian agencies at the discretion of buyers, lessees and mortgagees. The initiatives used various technologies available at the time.

The last jurisdiction to join the vendor disclosure system, the Northern Territory, suspended the commencement of provisions of the Sale of Land (Rights and Duties of Parties) Act 2010, which supported vendor disclosure on the basis that it would inconvenience Territorians and increase red tape associated with land sales (Attorney General's Press Release, 7 September 2012). Similarly, the newly elected conservative government in Queensland repealed disclosure of house emissions standards.

Victoria moved away from including status of climate change impact on titles and also removed the disclosure requirements in 2010.

Ultimately, disclosure systems will be substantially improved by implementation of a land information system (LIS) in which custodian agencies reveal their decisions and operations by attaching attribute descriptions to affected parcels and disclosing decisions through a map-based web service. Whole of government trends towards spatial enablement, address verification, and visual information services underpin the idea of a map-based LIS as the ultimate solution to management of information about restrictions, and as a secondary function, as a first point of information available to the public and all those affected, including buyers, mortgagees, lessees and others. Enquirers who need legally certified information require a unique service that would remain available for appropriate fees.

Adoption of a land information approach by state and territory governments and improved spatial information systems are inevitable though the changes involved are both extensive and expensive. Construction began after 2000 when the focus on consumers in land transactions shifted towards building information to frame responses to large-scale disasters and to facilitate taxation collection tuned to land holding patterns. The emerging engagement of national agencies in land information will frame future directions.

Growth in demand for land information among national agencies

Especially since 2000, the national government has engaged in collecting and using land information. The range of uses is extensive and growing. Table 2 below, shows a selection of major initiatives, but does not include water and carbon information initiatives, or spatial information initiatives in the Australian government.

TABLE 2. AUSTRALIAN LAND DATA INITIATIVES		
Agency	Database	Purpose
Australian Taxation Office	Land transactions since 1999	To facilitate the collection of income tax, CGT and GST
Australian Electoral Commission	Voters in election districts on electoral roles	To verify voter enrolment and voters addresses according to electoral area boundaries
Australian Bureau of Agricultural and Research Economics	Non-arable land	To facilitate land management
Australian Prudential Regulation Authority	Risks and claims	To better manage insurance business sector
Centrelink	Land ownership	To administer pension entitlements
Australian Reserve Bank	Australian property markets	Australian property market data collectors were commissioned to provide timely and complete information about the property markets in major capital cities.
Australian Bureau of Statistics	House price indices Buildings Land account	Release of 3 June 05 contained price information to December quarter 2004 Historical data and home approval information An environmental dataset about land assets (2010)

Geoscience Australia		National Exposure Information System (NEXIS) Risk assessment opportunities (COAG, 2003)
Department of Climate Change and Energy Efficiency	Performance ratings for buildings	<p>To implement climate change initiatives by providing information about buildings, underpin the Green Buildings initiatives, and allow rating of buildings for operational impacts on environment under the Building Energy Efficiency Disclosure Act 2010</p> <p>National Greenhouse and Energy Reporting Act 2007 introduced a national framework for reporting information about greenhouse gas emissions, greenhouse gas projects, and energy use and production by corporations.</p> <p>This act will underpin a carbon tax and emissions trading scheme that may be introduced.</p>

These independent initiatives of agencies can be improved and systematised. The Office of Spatial Policy in the Department of Resources Energy and Tourism is reviewing opportunities for streamlining as recommended by the Lawrence Report (2012), notably investigating whole of government initiatives including a licensing framework that would replace multiple negotiations between users and suppliers. In creating a LIS, the treatment of water information illustrates possibilities for land information administrators and users.

The Contrast of Management of National Water Information

Australia unbundled water from land in order to initiate water right trading among private owners. The new trading system required building of institutions to support titling and transactions. Management of water was stressed by the decade of severe drought (2000–2010) and subsequent floods.

The state governments comparatively lacked water governance resources to support large-scale information responses. Continental scale efforts demanded national funding from the Australian Government. A major

initiative involved improving Australia's water information. The Water Act 2007 (Cth) in Section 7 authorised the Bureau of Meteorology to manage water information supplied by over 230 water entities nationwide, including water storage information for 250 sites. The Bureau's role in weather and climate information, and its public standing, made it the ideal entity for coordination of water information, reporting and assessments and forecasts.

The results of these initiatives are now available to the public, business and government. The Bureau's water information services are well used. A comprehensive and accessible description of integrated water governance is available on the web site of the National Water Commission. Comprehensive information about water governance in all mid-levels of government is organised according to colour-coded categories of:

- A. legislation, regulation, statutory instruments, licences
- B. institutions and individuals
- C. non-statutory documents and activities.

The web facility allows diagrammatic description in simple graphics of water governance in all states and territories, national systems and cross-boundary systems according to business areas of water pricing and economic regulation, water planning and management, water markets, water supply and services and water quality management. All the key instruments, documents and descriptors are directly accessible.

This comprehensive overview of water management on a national scale is exactly what is missing from land management where the historical silos remain in place.

Building a land management governance chart would be more difficult than its equivalent in water because of the nature of land, diversity of land uses, the historical and various sources of land concepts and tenures, and the complexity of legal fabric. As an indicator of the difficulties in land management, efforts to build a national tenure ontology or tenure type list strike divergent state and territory approaches. The 1993 Land Tenure Map (updated) provides information on a 50 square kilometre data set and avoids the ignominy of detail.

At the pragmatic level, Australian land administrators have learned to live with solutions that are 'under continuous improvement' in order to gather

the 90+% utility available from taking comprehensive national approaches to solving problems. The national cadastre and national geocoded address file remain indicative successes of this pragmatic approach. Should management of land information be afforded the strategic design, legislative framework, and unlimited funds similar to the water system, Australia would be a world leader. In truth, however, leadership requires clever, not expensive responses. Water governance initiatives that can be adapted for good governance in land administration and land information include:

- Publication of a land dictionary of the most commonly used terms, like the water dictionary of national water commission, perhaps through Geoscience Australia, with key words defined and identified sources of the authoritative definition. Words like 'contract of sale', 'transfer', 'settlement' 'native title', 'freehold', 'leasehold', 'retail lease', 'residential lease', 'road', and so on can be defined to assist public understanding. The construction can be iterative, with new terms added over time.
- Mandate an authority for collection of crucial information in a key organisation, similar to the Bureau of Meteorology and the water information data under the Water Act 2007. PSMA has the track record of information handling and supply and is an obvious candidate.
- Publish an integrated description of land governance arrangements in Australia in a national site hosted perhaps by ANZLIC similar to the water governance page run by the National Water Commission: <http://www.nwc.gov.au/www/html/112-water-governance.asp>. The governance arrangements should include a description of land information initiatives (e.g. Western Australia's dictionary of interests in land and Queensland's administrative advices), and describe different approaches used in NSW in its information warehouse and central register of interests and Tasmania's Land Information System (LIST).

The water analogy goes only so far: water disrespects jurisdictional boundaries and invites national attention. Land lies within a discrete jurisdiction and its management is jurisdictionally guarded. As a corollary, land information is viewed as a state and territory asset, and its use is negotiated on a case-by-case basis between them and the increasing number of national government users. The cost of administration of this system is not measurable but must be considerable. Its cost and complexity invites consideration of streamlining the interchange through a national licensing arrangement.

Features of a National System

Move from Information Access to Information Services

Google's decisions to move from 'Location based products' to provision of information services (Google 9/7 2012) were designed to strategically position the corporation in the global information trade to support its business model. This paradigm shift from delivery of something to provision of services is a clear future trend and is recognised even in government information strategies (VSI 2014). However the shift is difficult to deliver in the context of land information where accuracy and reliability must be priorities and respect for economic and social sensitivities of information is imperative.

The changes involved are substantial given the differences in approaches:

- a. Information delivery approach reflects historical characteristics.
- b. Information is provided by silo agencies.
- c. Jurisdictions sometimes provide a facility that allows information from multiple silos to be acquired through a single postbox or facility that supplies static.pdf certificates or postal response to web request – the typical vendor disclosure or list based systems.
- d. Jurisdictions sometimes provide direct web-enabled access to multiple silos.

Information services approach reflects potential characteristics:

- a. The best practice model offers facilities of web-enabled single parcel based enquiry that delivers comprehensive information of all relevant RRRs – a modification of the list system.
- b. Information is available on single parcels through a web enabled, geocoded address based service providing a cascade of all the interests affecting the parcel including all or most important government RRRs, sale price and valuation history, transaction history, and authoritative hazard determinations.
- c. Generic information services are available throughout governments, business and communities at all levels through a web-enabled, map-based, spatially enabled, whole of jurisdiction enquiry for each RRR and data set. The information is interoperable, scalable, visualisable, capable of supporting mass numbers of parcel-based enquiries and whole of state enquiries.

The move to information services requires custodian agencies to continually update information that is reliable, managed, accessible and sourced direct from them. Users of land information need to spatially

enable their systems so that place is an attribute and a sorter of their non-land information. The information sets need to be capable of integration with information about attributes managed by many other custodians.

Integration of Land Information into Compliance Activities

Compliance activities involve increasingly complicated arrays of attributes, some of which are singularly determinative, and more of which are determinative in unique combinations. Much of this determinative impact comes from attributes identified in legal sources. Ever-changing relationships between land (parcels, properties and sites of business activities), users, managers, owners (as individuals, aggregated owners, corporate owners, trustee holders, land-rich entities, earners of particular incomes, and many more), times, refined legal concepts and relationships among them that determine pension entitlements, taxation liabilities, and more. This attribute data changes rapidly and unpredictably in many situations. With modern compliance activities, it is not just the owner we are interested in. It is the kind of owner and the relationship of the owner with taxing authorities, stamp duty collectors, land tax collectors and so on.

Revitalisation of Land Information and its Functions in Government

Approaches to information management among the states and territories vary according to local needs and capacities. The PSMA model of collaboration is working well to create national scale products of CadLite, GNAF and the newly released property data file.

Obvious Initiatives that Remain

Tools for national system are theoretically identified. SDI is globally recognised, but no implementation path is identified in Australia. The funding and legal structure to establish SDI needs to be modelled nationally. The model of a national LIS needs to anticipate emerging trends:

- gaps in information about lesser tenures, especially leases and mortgages
- inclusion of building information
- inclusion volunteered geographic information
- development of a features of interest dataset by PSMA Australia
- emergence of national electronic conveyancing services by NECDL that change in data generation and usage if managed successfully
- inclusion of information from local governments via the mid-level datasets of states and territories.

Business Model

National Victorian and Queensland governments accept a 'free to use' concept with spatial information, though specification of what is 'spatial' is imprecise. Free to user is an inadequate business model for sustainable land information of AAA quality. The maintenance of highly reliable information capable of underpinning various functions of government, utilities, and business, and instilling community confidence requires continuous operating funds, plus capital to support research and development. The business model of the land information system in Western Australia offers a model for holistic land information management. The free Information Dictionary provides succinct information about 85 interests on land. Interest reports are available to subscribers, and identify some of the interests that affect the 'selected land'. These services are user paid: unless users pay; taxpayers must meet the information maintenance and service costs; and the business of land information is subject to political imperatives, as is every item on the consolidated revenue agenda.

A common licence is an essential step, but information management requires extensive human and financial resources. Articulation of a business case for a national approach, achieved through collaboration among eight disparate state and territory jurisdictions is another essential step.

Conclusion

Land information is a national asset that can be used much more successfully throughout the tiers of Australian governments, and throughout each tier. Different kinds of information have different qualities. The significance of land information from Australian Torrens registries lies in its reliability: its standard is AAA. Owner, parcel, interest and transaction (OPIT) information is well understood as key to the management of rights, restrictions and responsibilities in land. The potential of this information is obvious, even while meeting the limitations of privacy, licensing, compliances and cost.

The information about parcel boundaries is also the best available information Australia produces about the human scale of land use. When translated into digital environments, this information carries the unique features of its source – the activities of surveyors and registry personnel. The digital version of this data set does not have to be legally determinative in order to be remarkably useful.

Now that the parcel map is translated into a national data file, called CadLite, through the collaborative efforts of the eight jurisdictions in the Public Sector Mapping Agency, its use can be much more extensive throughout government. Another national-related product, is the geocoded national address file (GNAF) of the addresses used to identify parcels and properties for practical purposes of mail delivery, census, and voting, among others.

The growth in regulation systems in management of restrictions on land, and the use of land information among national agencies are trends evident to observers. These trends suggest that management of land information would benefit from the national approach taken to management of information about water. There are of course differences. Meanwhile, an information services approach to land information management suggests that OPIT and parcel map information should be primary key data sets for Australia, anticipating the arrival of electronic conveyancing. The services approach also suggests that land information, given its inherent value and cost of maintenance, should attract a fee for use capable of ensuring it retains its AAA status.

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Chapter 3: A Framework for a National Land Information Infrastructure

Brian Marwick

Overview

As a federated country, Australia's land administration systems are state and territory based. These systems, which record information pertaining to land ownership, land tenure, land use and land valuation, have supported and continued to support the requirements of the respective states and territories (Bennett et al., 2011). Increasingly however, as initiatives that have a national focus (e.g. carbon trading, environment issues, etc.) come into play, the limitations in gaining current reliable land administrative data at a national level become apparent. Many businesses, some of whom may need access to national land information, are also becoming more nationally focused as evidenced by the 70% growth in businesses operating across state borders between 2003 and 2007 (OECD, 2010).

The push to operate more effectively nationally across a range of activities has increased over the past decade. This was clearly evident when in 2009 the Council of Australian Governments (COAG) initiated the concept of a seamless national economy (COAG Reform Council 2009). This resulted in some 27 projects aimed at reducing regulation that were impacting the efficiency of doing business in Australia. Whilst only two of these projects would directly affect land administration in the state and territories, this COAG initiative clearly demonstrated the growing need for many of the systems, which were state-based, to either be replaced by national regulations or achieve similar outcomes through the implementation of an overarching system, which would draw together the state-based systems to form a national view.

A number of initiatives (e.g. PSMA Australia, National Electronic Conveyancing, ANZLIC, etc.) have commenced over the past years, which

have met some of the land information requirements (Bennett et al., 2011); however, there remains a need for a cohesive, more complete, more current and cost-effective approach to support Australia's need in this regard. The challenge facing Australia is: how does it take advantage of the good land administrative systems operating at the state and territory level such that that same information can be viewed from a national perspective?

Assuming the need exists for a national land administration information infrastructure, how could this best be built? As previously mentioned, land administration data in Australia is essentially a state and territory based environment where their systems support their respective land developments processes as well as generating revenue. Given this situation it would appear the most feasible option available to achieve a national infrastructure is to build an overarching environment that consumes the key elements of the land information held by these systems.

Resolution of the problem can only be achieved by the implementation of a national land information infrastructure through a collaborative effort between all the governments of Australia. To a significant degree, processes have been underway for the past twenty years and have been slowly evolving; however, significant gaps in a national approach remain and existing processes are not delivering national land information in all the required areas. Essentially defining a national land information infrastructure is the role of the Australian government, not as the owner or necessarily the facilitator, but as, first, the major client and, second, as the potential source of the funds to strengthen slowly evolving processes.

The land Information and Services Business Model

The two ventures outlined below follow much the same pattern in establishing a national system or data set from information held by the states and territories and perhaps provide some guidance on the establishment of a national infrastructure.

In the case of PSMA Australia, the Australian Bureau of Statistics (ABS) required in the early 1990s developed a specification of their needs with regards land information, sought a supplier whom they were prepared to pay for the delivery of these services. The price for the delivery of the service was based on the specifications. As a result, the Public Sector Mapping Agency comprising all the state and territory governments was formed and delivered on ABS's requirement. This organisation would later become PSMA Australia (Paull, 2009).

In the case of National Electronic Conveyancing Development Ltd (NECDL), pressure from the business community to some degree brought about COAG nominating electronic conveyancing as part of the seamless economy agenda (Merritt, 2008). This followed the collective efforts over the previous years by a number of the state governments directed towards a national approach to electronic conveyancing. As major beneficiaries, the banks played a significant role in specifying their requirements of the system and input capital into the process to ensure its successful completion (NECDL, 2011).

These instances demonstrate that the major beneficiaries of national systems or data sets must:

- provide a clear understanding of their requirements
- be prepared to contribute a significant proportion of the funds to the project.

In neither case did the major user of the service take control of the company formed to deliver the service but left to the states and territories. PSMA Australia has successfully delivered several significant national spatial datasets on a quarterly basis since its establishment in 1992 (Paull, 2009). Whilst the national electronic conveyancing system is yet to be delivered, it is well on its way (NECDL, 2012a).

Both PSMA Australia (Paull, 2009) and NEDCL (NECDL, 2012b) are based on a similar corporate model and operate under corporate law as does any other company. Their shareholders ensure access to information and to the details of local administrative arrangements affecting the custodian organisations that create and manage the information. Thus the intimate details of administrative management in its various guises, as changes are made by sequential governments, are within its natural and comfortable purview. The political and bureaucratic changes occur without diminution of the national information products.

What does all this mean for a national land information management infrastructure where the states and territories have responsibility for land administration in their respective jurisdictions? It essentially demonstrates that major users of national services and or datasets involving land administrative data must take the initiative in identifying their needs and be prepared to significantly contribute to an initiative that satisfies them.

The Lawrence report prepared for the Australian Government clearly identified a considerable need for spatial data at a national level including

the fundamental land administrative datasets such as owner, valuation, planning, land use, and development status (Lawrence, 2011). Whilst a number of departments utilise the PSMA Australia national spatial datasets, some departments seek the required information directly from the State and Territory governments. This is particularly the case where PSMA Australia do not have the necessary information. There is also some concern that the information acquired either through PSMA Australia or directly from the respective jurisdictions is not to the standards required by the Australian government departments (Lawrence, 2011). These jurisdictional governments however have no incentive to bring the data up to the standards required by the Australian government particularly when information services already meet their local requirements.

The initiation of a collaborative approach to develop a singular specification that would apply across, effective throughout the Australian government, is however problematic. In 2001 the Office of Spatial Data Management (OSDM) was created by the Australian Government to facilitate some cohesion across the Australian Government departments and agencies. Whilst a degree of success in some areas was achieved, a singular approach to data acquisition from the States and Territories was not developed. A review of Geoscience Australia in 2010 recommended that a new policy office replace OSDM and that it be under the direct control of the secretary of the Department of Resources, Energy and Tourism to increase its horizontal reach across the departments (Commonwealth of Australia, 2011). This recommendation brought about the establishment of the Office of Spatial Policy (OSP). A location data policy framework was also developed by the APS 200 committee (Scott et al., 2011). These recent initiatives certainly provide the impetus to provide and develop the vital cohesive approach within the Australian Government.

Components of a National Collaborative Model

A collaborative model to support a national land information infrastructure for Australia must reflect the involvement of all three levels of government (i.e. local, state and federal), either as data generators, data integrators or as data users.

The structure of the model must be deliberately simple. Three operational collaborative systems need to work with each other towards specific goals, plus an overarching standards and review body. The degree to which of the four components successfully meets their respective goals, will determine the degree of success of the national model. It is a model that can evolve

over time as various data themes are developed and as some of the new processes become entrenched in the operations of the various levels of government. The overarching body would have no statutory control over the various collaborative models but would publish reports to all levels of governments on the progress being made.

Local – State Government Data Integration and Data Supply Tier

Local government represents the foundation or source of much of the land information required to support a national land information infrastructure. At the local government level information pertaining to land such as addresses, valuation, land use, building and occupancy details are generated to support various state legislative processes. Whilst local government requires this information to fulfil its operational requirements, much of the information is also required to underpin broader state government policy and operation requirements. To this end, each state government collects and integrates, normally as part of legislative requirements, each of these data themes into its various databases. In some cases there is no legislative requirement; however, operational requirements over the years have led to the establishment of practices that bring about the data integration (e.g. street addresses in most states). Many of these data themes are held as discrete databases at a state government level although over these past years, there have been some efforts to align the themes. As a general rule each of these databases meets the respective state and local government legislative and operational requirements.

This data integration between local government and state government represents the first tier of a collaborative model required as part of an overall national land information infrastructure. Essentially this tier is driven by long standing operational requirements for the effective operation of each state and territory. Whilst further improvements to support the national requirements are needed, particularly with a more consistent approach to the timely collection of data by state governments, data standardisation and better alignment of the various themes, this tier of the model is already functioning and fulfilling much of its requirement towards a national infrastructure.

Australian Government – Major Client Tier

Jumping over the middle tier of the model to the Australian Government tier of the model we find many government departments and agencies are seeking access to the land information generated by both state and local government. The creation of national spatial datasets by PSMA Australia such as Cadlite, Transport dataset and Addresses has certainly improved this situation as shown by the widespread use by Australian government departments of the PSMA datasets. These PSMA datasets however do not meet all the Australian Government's requirements either in terms of content e.g. (valuation, land use), data currency and in some cases data quality (Lawrence, 2011). As previously mentioned apart from the initial specification by ABS in the early 1990's, which brought about the creation of PSMA Australia, the Australian Government collectively has failed to outline what its requirements are. With each Australian government department focusing on its own requirements there has been no collective effort to define the broader requirements of the government. Unlike the local government/state government tier of the proposed national model there has been no operational requirement to do so. With the establishment of the Office of Spatial Policy (OSP) and work of the APS200 Location project, this tier of the model could not be considered a work in progress but it remains to be put into place. Essentially this tier involves collaboration across all Australian government departments to deliver a specification that will support their overall requirements. This would involve individual departments acknowledging their current and future requirements and their current costs in working across multiple state and local government departments in collecting and translating land information into their respective datasets. Only through this work would the Australian Government assess the true value of land information to the development of policies and their operational needs. In summary this tier of the national model is yet to be realised.

State and Territory Government Integration Tier

The final tier of the national infrastructure is the integration of the state and local government data into national datasets. To a significant degree much of the framework for this is in place. PSMA Australia has been in existence for nearly 20 years and NECDL is in the process of establishing a national land conveyancing system, which will link up the various land registries around Australia. Whilst owned to a very significant degree by the governments of Australia, they are not funded by government for their operational requirements and as such rely on the development of products that meet the needs to a client prepared to pay for the service or resource.

It would be expected that if the major client (i.e. the Australian Government) detailed its requirements with regards to land information in terms of content and quality, either PSMA or NECDL could assess the requirements and costs of doing so in conjunction with the states and territories as the respective sources of the data. This is no different to any company operating in the private sector where a potential client is seeking a new or improved product.

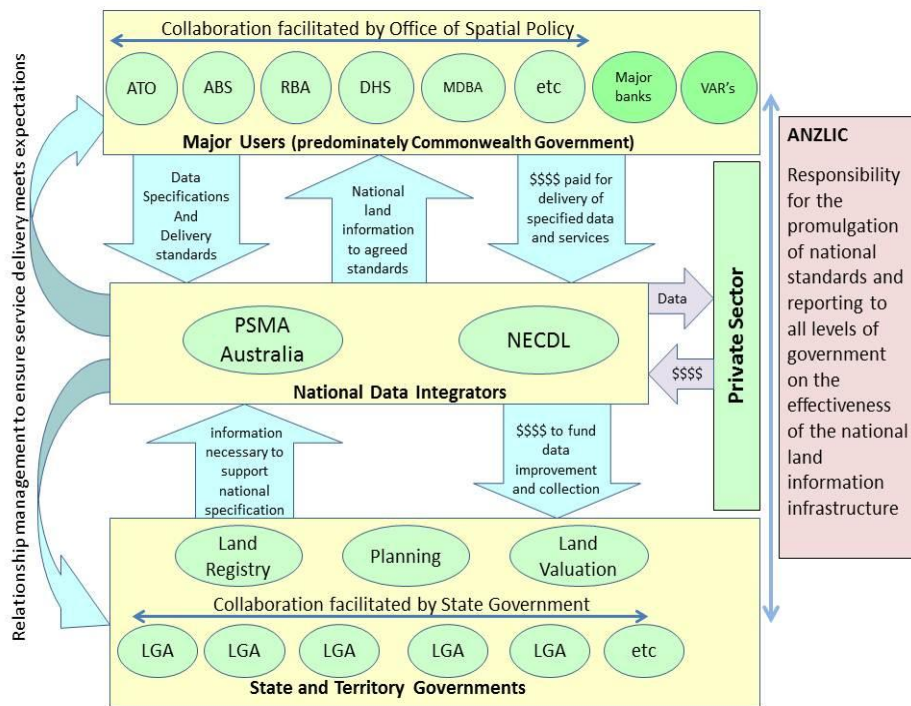
In the case of PSMA Australia, which has in place Value Added Retail (VAR) network, an assessment could also be made of the wider use by business of new and improved products.

In summary, the national integration tier of the model to bring together the state-based data already exists and is in operation; however, like any private sector company it will only deliver to what the market place requires and is prepared to pay for.

National Standards and Review Body

This body also already exists in the form of ANZLIC. This organisation is comprised of representatives from the Australian, State and Territory Governments and as such is well placed to report back to all governments on a regular basis on the progress of the three tiers of the model. It will also take the requirements of the Australian Government as the major client together with any additional requirements it deems necessary and create standards across the various datasets. It already performs this role and has completed a number of standards such as the Addressing, Transport and Cadastral standards. Preferably its constituency could be expanded to include a local government representative given the key role local government play in the land information process.

The diagram below sets out the key components of the model and the relationships that are critical to its success.



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Chapter 4: Land Administration for Housing Production

Muyiwa Agunbiade

Overview

The integration of land administration processes and the collaboration of land agencies are considered essential for the effective delivery of developable land for housing production. However, in most countries, housing and land management policies are usually split between multiple government agencies. The background literature suggests that the activities of governments' agencies that perform these functions are disparate and lack harmonisation. The lack of integration allows land administration agencies to operate according to their internal norms and functions. As a result, policy responses are inevitably disjointed – across and between different levels of government. This is considered more pronounced in federated countries than other systems of government.

This chapter presents the interrelationship across land administration functions (land tenure/registration, land value, land use and land development) and between different levels of government in the management and delivery of land for housing production. It *aims* to develop and evaluate a *Land Administration Integration Framework for Housing* (LAIFH) to improve inter-agency collaboration. The *methods* include the use of a case study approach. It focuses on federated case countries of Nigeria and Australia.

This study is framed within the proposition that the inadequate integration across land administration functions and between different levels of government impedes land delivery for housing production. The proposition is not to assume that inter-agency integration is linear and unproblematic, or that it is the only problem impeding housing production. The research is contextualised and aligned closely to the perspective of Puonti (2004), that the necessary starting point for the analysis of inter-agency integration:

'...is not [just] to take collaboration between authorities as a fact or an ideal model to strive for, but rather to study it as a learning process with tensions and difficulties as well as insights and innovations.'

From this perspective, collaboration between agencies responsible for land administration is not seen as an end but rather a means of facilitating efficiency and effectiveness of policies, processes, and spatial data infrastructures development among agencies.

Aim

This research investigates the inter-agency integration as it affects the delivery of land for housing production. The aim was to develop and evaluate a 'LAIFH' to improve inter-agency integration across land administration functions and between different levels of government.

Through:

- development of inter-agency integration assessment framework to measure and compare the depth of integration across land administration functions and breadth of integration between levels of government
- development of strategies to improve integration.

Justification

One of the requirements for appropriate policies and right decision making, in the context of spatial data infrastructures and land administration, is the reliance on collaborative interactions within and between jurisdictions (McDougall, 2006; Warnest, 2005). Given the importance of managing these complex interactions, it is argued in this research that the integration of land administration functions is significantly important to facilitate improved housing production

Several factors are important to necessitate a significant shift from the traditional *sil*o-based approach to an integrated management of land. These factors are drivers for collaboration among land agencies. They are considered to include, in addition to the technical considerations, issues of global, national, political, environmental and social interests.

Within the context of national land information infrastructure land administration for housing production, the following drivers were identified:

- simplification of the land development process for national businesses
- aiding spatial planning and infrastructure decisions for all tiers of government
- considerations for 'social inclusion'
- enablement of national land administration information
- developing parameters for 'building information'

- Whole of Government (WoG) Approach in monitoring city growth
- population as a global and national driver of housing demand and supply
- Integration of land administration functions in the context of housing affordability.

Contributions to knowledge

The research develops: a conceptual framework that provides a comprehensive approach to understanding the relationship between land administration and housing production.

It is important to establish the link between land administration and housing production. This involves bringing together different theories, concepts and issues initially discussed. Within the context of how housing production is organised, land preparation is a major component. Essential aspects are: land policies, land administration and spatial data infrastructure. Given the importance of managing these complex interactions, it is argued in this thesis that the integration of land administration functions is significantly important to facilitate improved housing production.

The way this plays out is mediated by each country context and impacted how housing production is organised. Figure 1 illustrates the two directional links between land administration and housing production.

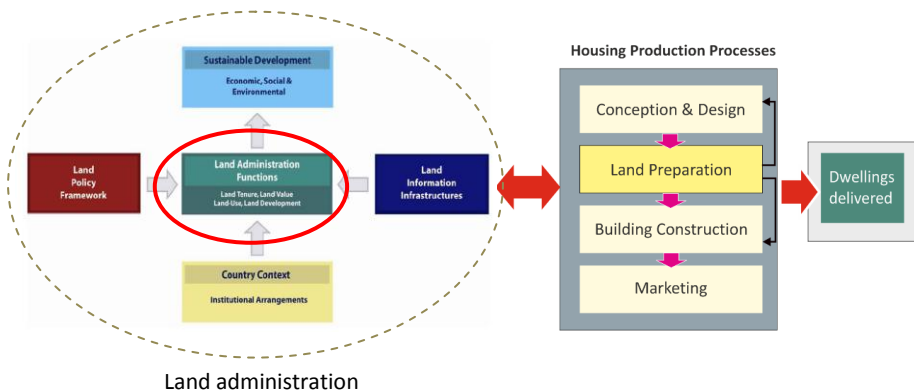


Figure 1: Land administration for housing production: The conceptual framework

The interactive link between land administration and housing production is an amalgam of the housing production processes and the land management paradigm. It illustrates how housing production is

underpinned by land administration as the core of land management paradigm and as the gateway to sustainable development. At the same time, the framework offers opportunity to explore how housing production processes provide context for understanding land management.

The study also developed an Inter-agency Integration Assessment Framework (IIAF) in the context of housing production to assess levels of integration. The parameters for the development of the IIAF were identified from different past studies. This is in parallel with the structured interviews conducted. These include:

Table 1: Land Administration integration parameters: aggregation of themes

Integration Assessment Parameters	Sources
Data creation: collection format	Dasgupta (2010); Participants interviewed
Data coordination and information flow	Williamson et al. (2010); Participants interviewed
Storage and Maintenance of data	Participants interviewed
Technology and technical issues	Williamson et al. (2010); Participants interviewed
Data services funding/pricing model	Richard and Tsiopoulos (1996); Participants interviewed
Spatial datasets dissemination and use	Onsrud and Rushton (1995), Participants interviewed
Economic considerations	Bryson et al. (2006)
Environmental considerations	Blair et al. (2003)
Social considerations	McGuirk (2008)
Communication between agencies	Darlington and Feeney (2008); Drabble (2007); Spath et al. (2008)
Public participation	Arnstein (1969)
Organisational structure	Bryson et al.. (2006); Bolland and Wilson (1994)
Commitments and responsibility	Agranoff and McGuire (2003)

Resources of the agencies	Keast et al. (2004), Participants interviewed
Dispute resolutions	Bryson et al. (2006); Participants interviewed
Capacity building	Rajabifard (2006); Masum (2011)

By adopting Social Network Analysis (SNA) and Paired Samples (T-Test), this study uses the IIAF developed to determine the levels of integration among agencies responsible for land administration. The approach allows graphical representation of the levels of integration among the agencies. By using Structural Equation Model with Partial-Least Square, as adopted tools, it was possible to verify the reliability of the assessment framework.

The findings, through the application of IIAF, show that the optimal level of inter-agency integration varies from one organisation to the other. This reflects the priority and the interest of each organisation. In this regard, the highest level, as conceived in the integration assessment framework, does not necessarily correspond to the optimal level desired by the agencies. This suggests that the assessment framework should be treated as a continuum.

Finally, the research developed a Land Administration Integration Framework for Housing (LAIFH) as strategy to improve inter-agency integration. The development of the IIAF is underpinned by the Conceptual Framework and was also based on the observed level of inter-agency interactions, relative to what was desired by the agencies. This is necessary to promote better integration of stakeholders required to deliver developable land for housing production

The LAIFH includes the development of a collaborative process. It also considers the contextual factors that affect ownership rights and a linked process for determining development rights. The link between the collaborative process and the contextual factor analyses is what is required to support efficient land delivery. The demonstrators: *housing development potential analysis and visualisation*, and the *analysis of development assessment approval* provide context for the application and evaluation of the integration framework.

Conclusion

Research investigations and empirical studies throughout this research demonstrated interrelated and complex range of inter-agency integration issues affecting land delivery for housing production. The focus, however, has been to improve inter-agency interaction to facilitate linked processes of ownership and development rights.

The key conclusion of the study is that policies are not sufficiently informed by evidence and that due to a disconnect between agencies, policies formulated do not stimulate integrated processes among land agencies and that the processes do not sufficiently drive the type of data that is collected.

Recommendation

It is thus *recommended* that managing land for housing production should follow the principles of evidence-informed policy, policy-based processes and process-driven data.

Future direction

Further research is suggested for other case study areas. This is to provide improve understanding of the *causal link* between variables of inter-agency interactions and the efficiency of the land delivery for housing production. This is in addition to developing indexes, by focusing on the contributions of land management, to measure housing outcomes: sustainability, affordability, liveability, and productivities.

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Chapter 5: Towards a National Land Information Infrastructure for Managing Layered Property Markets in Federated Countries

Nilofer Tambuwala

Overview

The dominant focus of how we live and operate in society has changed over the last decade, to the economic reality of scarce natural resources and a shared vision for sustainable development. New markets are emerging as a way to manage scarce resources as new land interests are recognised. Land administration provides the infrastructure for secure land market transactions, and government macroeconomic policies work to manage the economy as a whole. As new land markets develop, there is an increasing need for better, more reliable information for improved economic management of land and its resources.

This need is most evident in many federated market economies where land administration is undertaken by state, provincial, or local governments; while, macroeconomic policies to manage land markets occur at central level. In these countries, the capacity of independent, state-based land administration agencies to meet increasingly national drivers, particularly national economic policy, is challenging. This stems from an information asymmetry often caused by inadequate information flows between state and central governments. State-based laws and processes make it difficult for central policy departments to access integrated land information, to manage markets that are increasingly national in focus. Past, traditional approaches to improve land information access include:

- standard ontologies and conceptual schemas such as the Federated Data Model for land administration (Tuladhar and Radwan, 2005) and the Land Administration Domain Model (van Oosterom et al., 2006)
- collaborative approaches (Warnest et al., 2005; McDougall, 2006)
- systems theory (see Zevenbergen, 2001).

These, among others, have achieved varying levels of success. However new markets are threatened by information asymmetries in the land sector that still remain unchecked, and there is an increasing need for an unencumbered, innovative approach. In particular, the increasing focus on sustainable development, natural systems and 'green' economies has shown the utility of biomimicry. Biomimicry, a principle of natural capitalism, uses nature as a model, to study and design real-world systems that emulate the efficiency and sustainability of processes in nature. It allows for a new, modern approach to unify land administration and macroeconomic policy for sustainable development.

This chapter draws on principles from natural capitalism, to design a land market information flow lifecycle that establishes an operational link between land administration agencies and central macroeconomic policy departments, in federated market economies. It advocates holistic management of land and its resources for better national economic policy and sustainable development.

Research Problem and Significance

Increasingly, market mechanisms are being adopted to meet the changing focus of economic growth on sustainable development. Mixed capital economies in particular, operate fundamentally through a market structure, where the price of goods and services is controlled largely by supply and demand in the private sector, and regulated by public sector economic policy. The role of fiscal policy, or broadly speaking spending and taxes, is to maintain a balanced yet growing national economy. Controlling the revenue and expenditure of the public sector via fiscal policy is used as a means of combating unemployment and balancing the demand in the private sector.

Similarly monetary policy, generally controlled by a country's central bank, is used to regulate the supply of money and interest rates in the national economy. This serves as a means of achieving high employment, positive economic growth and low inflation.

In a land market, formal transactions are only possible through the existence of land administration infrastructures that allow for private land ownership to be registered, land values to be established, and rights in land to be exchanged in a market environment. As such, these administrative structures have a critical impact on the economy as a whole.

In many federated countries such as the United States, Australia and India, land administration functions fall into the constitutional authority of the state and territory governments. Essentially, the land registry that maintains ownership information is part of the state government. Information is sourced from various other departments, developers, surveyors or from local governments. Similarly, the land or property valuations department also forms part of the state governments. Often property valuation methods can be as varied as the property laws in various jurisdictions. Data relating to ownership and value of properties is generally stored in multiple jurisdictional databases.

In these countries, fiscal and monetary policies to manage the land markets are implemented at a central level. The major vehicle or tool is an increase or decrease to the bank rate of interest that feeds directly into the cost of borrowing for real estate transactions. If the information available to national agencies about the real state of the market is inaccurate, their ability to make sensible interventions is jeopardised.

For instance, the recent global financial crisis (2007 onwards) decreased real estate values in major market economies around the world. From the land administration perspective, part of this crisis was a result of poor decision making and ill-informed policy due to the lack of national property datasets, particularly in the United States (Buhler and Cowen, 2010). The financial crisis affected the federal governments of many economies through lower tax revenues and duties from both income and capital gains tax, and increased spending in the form of economic stimuli. Essentially, fiscal and monetary policy decisions to combat the financial crisis left many market economies with large budget deficits and significant foreign debt. By mid 2010, a sense of urgency was evident in efforts to redefine the role played by land administration in implementing central policies that manage land markets, especially in federated mixed capitalist nations.

In many mixed capitalist countries, sustainable development objectives to better manage scarce natural resources have led to new land rights that add to the complexity of administering land and economic management. Legal interests in land are increasingly complex and land management now involves environmental, heritage and use restrictions. New forms of property as tradable commodities are also emerging, for example water, biota, mining and carbon credits (Wallace and Williamson, 2006). These new markets involve new taxable commodities and transactions, and changes to the availability and supply of money in the economy. New interests in land resources must be attached to a land parcel to become

functional. As such, all marketable rights in land must be managed holistically to avoid new silo-like approaches emerging.

The heart of the problem lies in the need for increased information about transactions in land and resources, in order for economic policy decisions to meet a country’s sustainable development objectives. Where market mechanisms are being adopted, information asymmetries are a significant cause of market failure (Cohen and Winn, 2007). Federated countries in particular need to improve their administrative structures to enable a flow of information that minimises information asymmetries, between the government collectors and users of land information.

Traditional approaches to improve land information access have not adequately addressed the issue of information asymmetries between levels of government in federated countries, which can lead to market failure. This is of growing concern as new land markets emerge. A novel approach is needed. The research undertaken here is the first of its kind to apply the principles of natural capitalism to the discipline of land administration. It presents a land market information flow lifecycle, derived from cyclical processes in nature, to deliver a public good system. The system consists of principles to assist national integration of land transaction data held in diverse models and organisations. The research aims to bring together the disciplines of land administration, macroeconomic policy and sustainable development through a ‘conscious emulation of life’s genius’ (Benyus, 2002).

Major outcomes

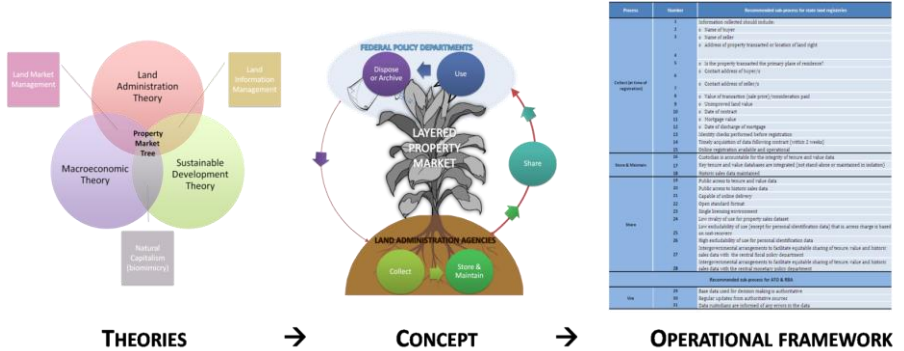


Figure 1: The theories, conceptual model and operational framework developed within this research.

This research project addresses the issues with current land administration processes in federated counties, and evaluates the need for national land information infrastructures for sustainable management of current and emerging land markets. The project presents a land market information flow lifecycle, derived from the principles of biomimicry, to achieve national integration of land information as a solution for minimising information asymmetries that can lead to market failure.

The following are the major outcomes of this work (Figure 1):

- i. understanding of link between land administration, macroeconomic policy, sustainable development and the role of natural capitalism
- ii. development of a new conceptual model for a national land information infrastructure
- iii. assessment of the model in practice to identify areas where the model can be improved to create an operational tool. Using a case study approach, land information flows in the following state-based land and resource markets in Australia are mapped against the conceptual model:
 - property and water markets in Victoria
 - property and water markets in Western Australia
 - property, water and carbon markets in New South Wales
- iv. Principles are derived from the case studies to refine the model into an operational framework that can be used to achieve a national land information infrastructure.

A potential application of integrated market transaction information is also presented via the 3D property market tool, as an added decision-making aid. It is based on the property object approach (Kaufmann and Steudler, 1998, Van Oosterom et al., 2006, Bennett et al., 2008), and visualises transactions in the form of tax and interest objects: Figure 2.

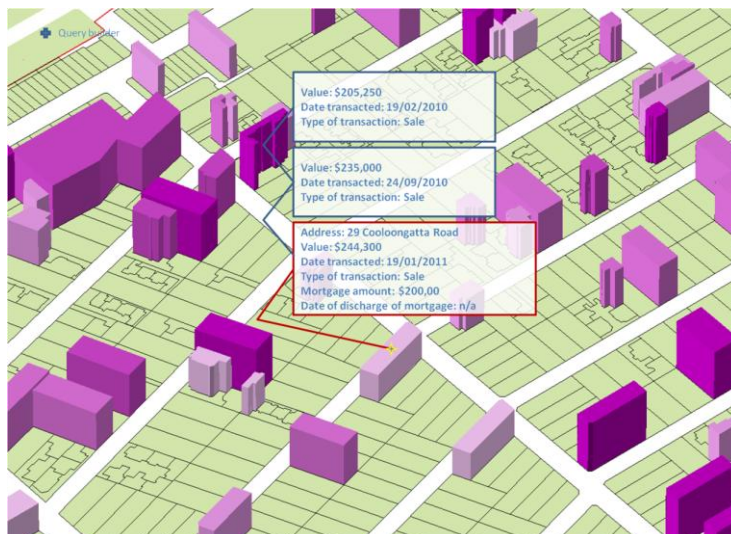


Figure 2: 3D property market tool showing attribute data attached to an interest/tax object.

Future directions

This research does not claim to fully solve the problem of a national land information infrastructure; and needs to be built upon particularly to:

- understand the land information needs of other central government departments and national agencies and to establish a dissemination framework
- understand how informal land markets can be better accounted for within a country's economy
- determine the functionality of other land related resources, such as mineral deposits, timber and fisheries in relation to land.

Recommendations

Technological advancements have enabled land administration processes to evolve from paper-based to digital systems. Better integration at a national level can be achieved and needs to be prioritised. User-driven information collection and cross-governmental sharing will be key to meeting the land information requirements of central policy makers.

New options for enabling more seamless land information flows need to be prioritised, enabling horizontal integration of jurisdictional datasets, followed by vertical integration from local to national level. The statutory powers of state government land agencies need to allow for increased data sharing. Siloed approaches need to be acknowledged and incorporated into a nation-wide land information infrastructure.

Independent land administration agencies have the incentive to make significant economic gains by repairing their institution frameworks and incorporating cross-governmental sharing into their business models. Central government policy makers have the opportunity to recognise the invaluable authoritative data stores currently available within state land agencies. There is great potential for improved access to this authoritative and assured land information as the evidence-base for policy making.

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Chapter 6: Supporting Land and Property Risk Management Activities with Land Administration Systems

Katie Potts

Overview

Several major disaster events in Australian communities during the late 2000s have drawn attention to risk management practices within Australia. The outcomes of the disaster events have shown that effective risk management is not as prevalent in communities across Australia as believed. A limited understanding of risk management by the general public, a lack of awareness of land and property information, and barriers preventing easy access to information have been highlighted as some key reasons why effective risk management is absent in communities across Australia (Armitage 2012; Fanning 2012; Han 2012; van den Hoenert and McAneney 2012).

Research has shown that the use of land and property information for disaster and emergency management can improve operations (Mansourian et al. 2004; Asante et al. 2007), and as demonstrated by recent amendments to disaster and emergency management models to enable the inclusion of risk management processes (c.f. Ellis et al. 2004; UK Resilience 2010; Rogers 2011), this improvement can be translated to risk management. Some stakeholders have recognised this and the value inherent to land and property information for identifying, analysing, evaluating, and selecting treatments for risks has been realised and documented (c.f. Productivity Commission 2012; Insurance Council of Australia 2006), however for the majority of stakeholders the utility of land administration data is limited to mitigating the risk of fraud.

As the primary custodians of land and property information, land administration agencies have the role of creating, maintaining and publishing this information. Facilitating more effective dissemination would contribute to improved risk management practices for society. However,

the task for providing information for risks other than fraud management has not been extensively explored.

Land administration has much to offer the discipline of risk management; however, the role land administration agencies can play needs to be investigated. This chapter looks at the world from a risk management perspective to understand how land administration systems and agencies need to change to contribute to the management of risks affecting land and property. The investigation process involved assessing land right holders and their risk management activities, and examining the existing land administration systems and agencies to determine how they are arranged and operate. The results of the two enquiries inform the changes required in order for land administration systems to support current risk management activities related to land and property. Figure 1 illustrates this process.

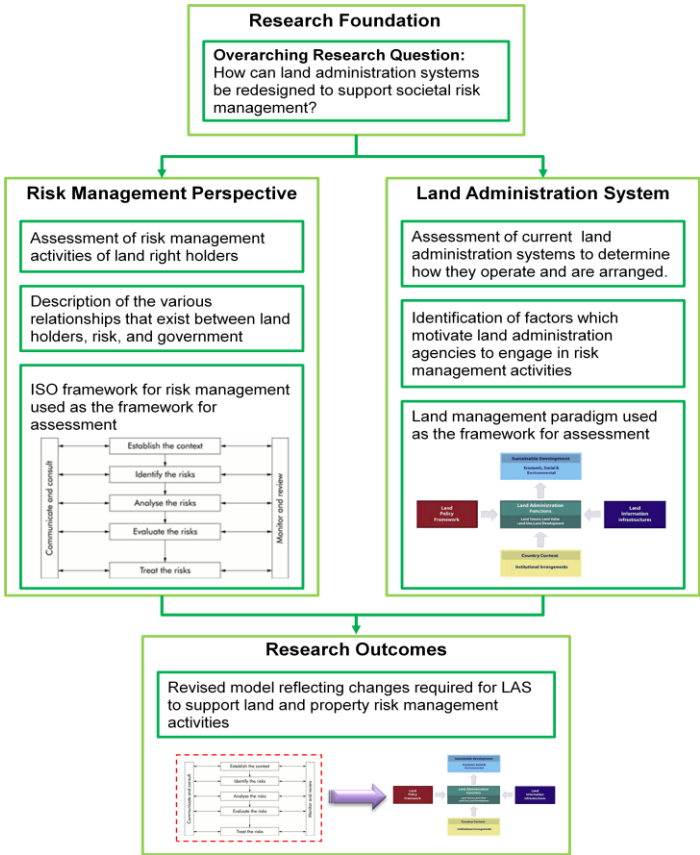


Figure 1: The investigation process

The problem under investigation can be summarised into the statement below:

Conventionally land administration systems are only organised to manage the risk of fraud. Today, current land administration systems have evolved and have the potential to facilitate the management of multiple risks; however, current arrangements limit this advancement.

The articulation of the problem then leads to the aim, which is:

To revise the design and function of current land administration systems to incorporate the principles of risk management.

The primary question that this research addresses is: How can land administration activities be redesigned to support societal risk management? Breaking this overarching question down into smaller investigative pieces a number of smaller questions emerge to direct paths of enquiry. These sub-questions are:

1. Are land administration agencies motivated by the notion of risk management? If yes, how?
This question aims to understand the priorities of land administration systems and determine their focus, whether it be risk management or otherwise.
2. How do land right holders perceive the role of risk management?
This question looks at how land right holders understand risk management, and what risk management is believed to be. It also looks at the roles of risk management and who the different stakeholders in society view as responsible for that role.
3. What should be the relationship between landholders, risk, and government? Or what are the various options?
This question relates to the different roles of risk management, and which stakeholder should be responsible for what role.
4. How can land administration systems support risk management – given a specific country context?
This final question addresses legal, organisational, and technical characteristics of land administration agencies that carry out risk management well to determine a framework to support risk management.

Research Significance

This research is important as it addresses an issue that is of national importance. Improved risk management is required to increase community resilience against risks. Land and property information has been shown to assist in risk management practices by allowing stakeholders to understand and realise risk, which threaten their land and property. As the primary custodians of land and property information, land administration agencies have the role of creating, maintaining and publishing this information. Facilitating more effective dissemination would contribute to improved risk management practices for society. However, the task of providing information for risks other than fraud management has not been extensively explored. This research is addressing this problem.

Research Contributions

This research will enable improved risk management practices to take place by creating a greater awareness of risk management and how it can be implemented to better manage land and property. A better understanding of risk management processes will improve community resilience and support the government initiative that encourages communities and citizens to understand risks in order to achieve safer and more sustainable communities.

An outcome of the research will be a prototype demonstrating how land and property information, once organised in a way that supports risk management activities, can be used to assist in risk management processes and informing risk management decisions (Figure 2).

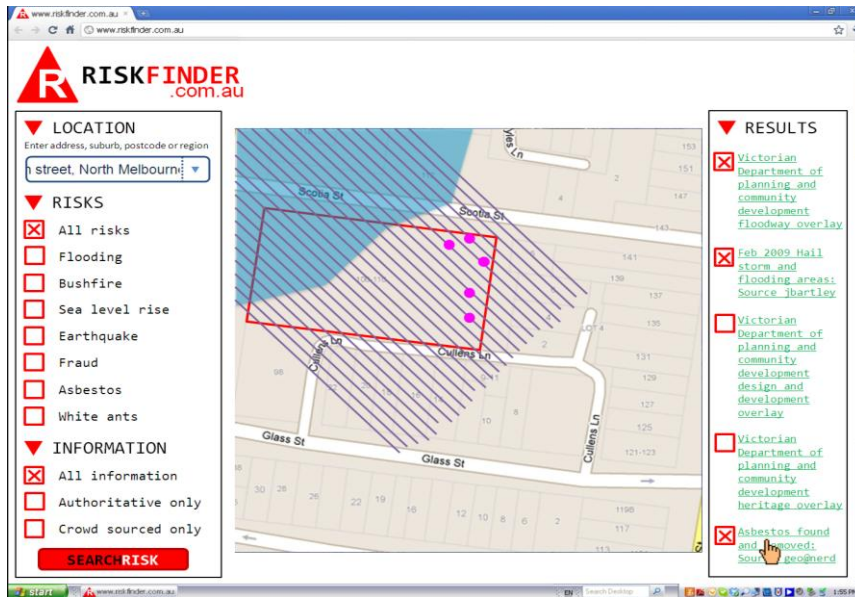


Figure 2: Risk Finder Prototype

Future Directions

Once this research has concluded further areas for investigation include to:

- explore how the principles of risk management that have been applied to managing risks to land and property can be expanded to enable application to other areas such as public safety
- investigate additional opportunities for land administration systems in the realm of risk management
- Explore how land administration activities might be further integrated into risk management practices.

Recommendations

The major recommendation from this research is that land administration systems adapt to enable support for risk management activities. This would involve possible changes to organisational, legal and technical aspects of the system. An understanding of risk management processes would also be required in order to assist in the role. It is recommended that access to, and awareness of, land and property information is made a priority to enable community preparedness for risks.

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Chapter 7: Towards 3D Land and Property Information: Engineering Institutional Change

Serene Ho

Overview

The aim of this chapter is to provide an understanding of the institutional infrastructure required to support a shift towards 3D paradigm in managing information regarding rights, restrictions and responsibilities (RRRs) associated with land and property.

Due to the prevalence of complex vertical developments, the limitations of current 2D practices in managing RRRs are most keenly felt in cities. The scope of this project is therefore limited to the land development process pertaining to these developments. An investigation into the current institutional arrangements that underpin transactions in land and property information constitutes a major part of the research focus.

Introduction

This research project is concerned with institutions that affect technological innovation in land and property information management, specifically 3D technologies and digital information. Land administration literature places significant emphasis on consideration of institutional context for the development of appropriate land administration processes (e.g. Enemark, 2004). However, analysis of institutional context is often undertaken without a theoretical framework specific to institutions. This precludes the ability to make comparisons across jurisdictions to deepen understanding of why some institutions work while others fail.

This project aims to incorporate insights from new institutional economics (NIE) and apply the Institutional Analysis and Development (IAD) framework as a specific framework for analysis of the institutions that support land and property information transactions. To overcome the issue of heterogeneity in the definition of 'institutions' in institutional research

(e.g. Commons, 1931; Ostrom, 1986; Scott, 1987; Crawford and Ostrom, 1995; Williamson, 2000; Aoki, 2005; Hodgson, 2006), this project will adopt the definition of institutions as 'the prescriptions that humans use to organise all forms of repetitive and structured interactions' (Ostrom, 2005). In addition to being a definition embraced within NIE, the focus of this definition on 'repetitive and structured interactions' aligns well with the conceptualisation of land administration as process-based systems (UNECE, 1996).

Research Problem

A move towards utilising 3D technologies and information for land and property information management and representation, particularly for urban areas, has been a recent focus in land research around the world. Similar efforts are evident in Australia, most notably in the states of Queensland and Victoria. However, planning to introduce and sustainably use new technologies requires consideration of drivers and disruptors of systemic change in well-established and conservative systems of administration, as well as, how proposed changes may affect interactions between different stakeholders. In the Australian context, current literature reveals little in the way of holistic understanding of institutional arrangements that support land and property information transactions across the land development process. Existing information has also not been examined with the use of any institution-specific theoretical framework, precluding the ability to develop any national recommendations from jurisdiction-specific research.

Consequently, the problem statement identified for this project is:

Current approaches to facilitate 3D technological innovation in land and property information transactions do not adequately account for institutional change, posing an impediment to implementation.

Institutional analysis based on a sound theoretical framework is therefore necessary to provide the foundation from which to develop the necessary institutional infrastructure.

Research Approach

Theoretical framework

The research applies and incorporates insights from new institutional economics (NIE). NIE combines transactional, behavioural and organisational realities in institutional analysis and provides an appropriate

theoretical framework. It is based on the classical microeconomic theory that links exchange to markets and its theories are generally accepted in land administration literature. The main proposition of NIE is that institutions (and an understanding of their mechanisms and effects) are crucial for economic performance (Furubotn and Richter, 2005). Transaction cost is used as the fundamental unit of economic decision-making, enabling the existence and persistence of institutions to be measured and analysed in terms of costs and benefits (e.g. Coase, 1997; DiMaggio and Powell, 1991; North 1992).

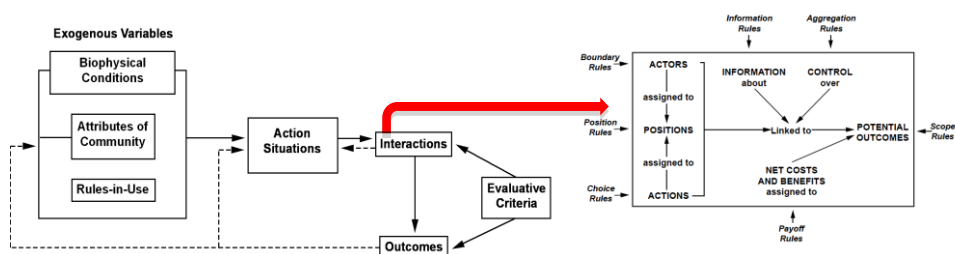


Fig. 1. The IAD framework (top), the internal structure of an action situation and the seven working rules that affect its components (Ostrom, 2005).

Practical framework

The Institutional Analysis and Development (IAD) framework will be applied to provide a schema for collecting empirical information from placements with various organisations (representing key stakeholders in the land development process). The action situation – where decisions are made – is the main focus of the IAD and is based on game theory. This aims to deconstruct information about decisions into ‘participants in positions who must decide among diverse actions in light of the information they possess about how actions are linked to potential outcomes and the costs and benefits assigned to actions and outcomes’ (McGinnis, 2011). The action situation can be considered in situ, or as a nested set of situations at three levels – constitutional choice, collective choice and operational choice (strategic to operational). This reflects the polycentric nature of many institutional settings, certainly evident within Australian land administration. Finally, the IAD is regarded as a meta-theory, which will facilitate comparative study and analysis of policies or institutional arrangements across different jurisdictional settings and support the aim to develop national recommendations.

Relevance to National Land Information Infrastructure

In developed countries where land administration practices tend to be mature, attention inevitably turns to improving the management of land information for prudential reasons. In response, technological developments are becoming a key feature of land research – new data models for improved information storage and representation, interoperable infrastructure, standards, use of semantic information and ontological approaches. The appeal and pace of such innovation can make it easy to lose sight of the fact that implementation of technology is contextualised by institutional arrangements.

In the context of developing a national land infrastructure, this project is significant for its concentration on the institutional aspects required to support successful innovation. The institutional issues that this project aims to elucidate will likely be typical of the broader institutional challenges encountered in developing a national land information infrastructure.

For example, the crux of the 3D issue is less about the inclusion of height information, and more to do with broader discourse related to evolving the institution of the terrestrial cadastre to align with land administration needs. Such an evolution is not jurisdiction specific and is occurring across Australian land administration systems, and indeed, around the world. In simplistic terms, the third ‘dimension’, often thought of literally as height, is perhaps more realistically conceptualised as an additional *aspect* of information, concerned with improving representation of relationships. These lie at the heart of supporting tenure security and exist as legal relationships, e.g. between interests, or the location of the spatial footprint of interests in vertical space in relation to the terrestrial land parcel; or as physical relationships, e.g. between interests and the natural environment, or the situation of interests in relation to the physical structure of the property itself.

The focus on 3D also brings up the issue of a broader move to embrace the digital era, which is already evident in other domains within information and communications technology. Current land administration systems in Australia are based on graphical practices – plan drawings, cross-sections, etc. A move towards a 3D environment demands the use of digital information to fully leverage benefits in improved querying abilities, re-use of data and representation of information. The provision of digital information and the desire to better represent the relationship aspect of information about RRRs leads inevitably to the question of moving towards

an object-oriented approach to information modelling. Prior work by Bennett (2007) and Kalantari (2008) introduced the concept of the property object and legal property object respectively. Current work to introduce a third dimension in land and property information can be regarded as an extension of these concepts to improve land administration processes.

The current cadastre is under pressure to evolve in response but to do so, institutions that underpin the entire lifecycle of land and property information management – from survey practices to data formats, needs to be examined. It is fundamentally a paradigm shift in the collection, management and production of land and property information to improve on existing capabilities in representing the legal and physical relationships between land and property interests. The ramifications of such a change extend from strategic – in terms of policies and governance of information, to operational such as changes in how land and property information is collected. A focus on costs and benefits in this research project leads also to identification of incentives for facilitating institutional changes.

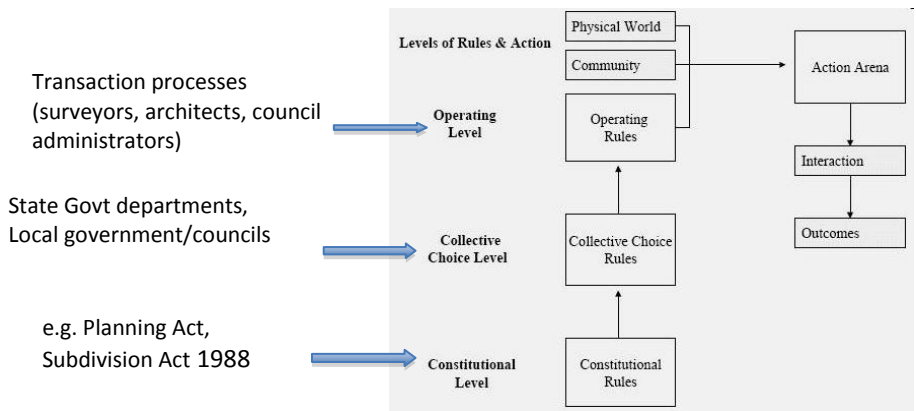


Figure 2. Potential for moving towards a 3D environment: considerations at the three institutional levels in Victoria.

Within Australia, some of these institutional challenges have begun to be addressed with a transition towards a digital environment for managing land and property information. At the same time, new challenges arise from the move towards national approaches to land and property information transactions, such as the implementation of eConveyancing and ePlan initiatives. In these initiatives, as in the transition from a 2D to a 3D environment, changes are potentially contested between lower and higher institutions. For example, current research on 3D cadastres emphasises legislative aspects that do not apply in Victoria since existing

laws pertaining to land and property (e.g. the Subdivision Act 1988) do not specifically exclude, limit or legislate against the use of 3D information. At the local government level, 3D models are increasingly used as a way of organising property information (e.g. City of Melbourne). As a result, obstacles to the implementation of a 3D environment are likely to lie with existing operational transactions and workflow processes. The application of the IAD in this research will facilitate understanding of how operational processes are influenced by higher-level institutions (see Figure 2).

Research Contribution

The anticipated contributions of this research are three-fold. Broadly, the insights from NIE will provide a substantial and cross-disciplinary theoretical basis for analysis of land administration systems and their components (encompassing organisations and processes). Importantly this theoretical basis will improve the capacity of land administrators to recommend and manage change in response to human and technical drivers.

Secondly, the research seeks to contribute to existing knowledge about the institutions that affect transactions in land and property information in developed democratic economies. There is often an assumption that stable institutions persist simply because they are right (e.g. Williamson, 1985); however, institutions are often less than appropriate because they are difficult things to change and because the cost of enacting change may be greater than the benefits that change might bring (e.g. Akerlofm 1976; Zucker, 1986; Mathews, 1986 – in DiMaggio and Powell, 1991). While it is important to understand how institutions come about and operate, it is just as important to determine if institutions are responding appropriately to needs and how best to implement change – this is especially important to those who have the responsibility for shaping and developing rules for society (Ostrom, 2005).

Finally, by examining the institutions relevant to realising a third dimension in land and property information, this research seeks to make specific contributions to facilitate the adoption and implementation of 3D technological innovations to benefit land administration practices and processes in an Australian context.

Future Directions

The next steps involve applying the theoretical approach in the empirical institutional operations of land and property information transactions, to establish what institutional changes will facilitate the move towards a 3D environment and to provide the basis for appropriate policy design. Work has already commenced with putting together a case study for Melbourne with placements at Land Victoria and the City of Melbourne, and regular meetings with Vekta. 2013 will likely see similar work undertaken in Adelaide to build a comparative case study.

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Chapter 8: Trends in 3D land Information Collection and Management

Ida Jazayeri

Introduction

The spatial representations of our world, both natural and built, are being increasingly described using 3D geospatial models. The creation of accurate, photorealistic 3D city models that can be used in real-world applications still remains a challenging problem in spatial information science. Three-dimensional modelling is required in applications as diverse as urban planning, disaster management, asset management, environmental monitoring, navigation and intelligent transport systems. Such applications call for efficient methods for the creation, storage, retrieval, analysis and visualisation of 3D city models. This research relates to the NIMLI project in that land information can be managed and maintained in a virtual 3D platform.

A virtual 3D city model is a digital representation of urban objects on the Earth's surface, such as buildings and other related infrastructure. The model may also include topological information of the terrain by integration with a Digital Terrain Model (DTM). Virtual 3D city models are becoming more widely implemented around the world by organisational bodies such as governments, city planners and emergency services. Such organisations require highly detailed 3D models that reflect the complexity of city objects and the interrelations (Stadler and Kolbe, 2007).

The initiatives taking place around the world are extensive, ranging from commercial products such as Google Earth, or Bing Maps to more collaborative platforms based on open source software such as OpenStreetMap and Earth 3D. Government bodies, particularly local councils, are also embracing a 3D representation of their municipalities for better planning of their communities. In Victoria, Australia, the City of Melbourne and the City of Greater Geelong have accessible 3D models of

their council areas that have allowed for better planning and better management of their municipalities as illustrated in Figure 1.

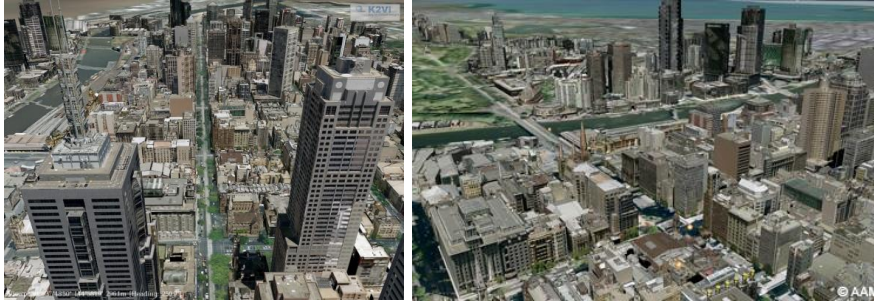


Figure 1: 3D model of Melbourne by AAM for the City of Melbourne

While 3D data has been collected and implemented in applications for many years, the recent advent in technology for data storage and integration has raised novel research challenges. The instrumentation also has developed significantly over the last few years and has allowed users to collect 3D data in real-time and over a larger area of coverage resulting from the use of GNSS (Dowman and Arora, 2012).

In addition, given the vast amount of visualisation techniques that have been developed over the last decades, and the variety of applications, user tasks and data formats, the selection of relevant visualisation techniques for the construct of a 3D city model is not an easy task. Moving towards an enriched 3D city model that addresses current challenges, such as data storage, data integration and data interoperability, as well as recent trends such as BIM, is far from trivial.

This chapter, which centres on an investigation of state-of-the-art three dimensional initiatives, focuses upon the initiatives taking place for the creation and application of accurate, photorealistic, virtual 3D city models that can be used to better manage and maintain geospatial information. The research goal is to review a range of the current initiatives taking place, and to identify the challenges that must be addressed towards the advancement of 3D city modelling.

3D Data Acquisition

Over the past 10 years, the most significant development in 3D data acquisition has been in laser scanning, both airborne and terrestrial. Advancements in digital photogrammetry have also meant that image-matching algorithms can be used produce 3D models fit to compete with laser scanning with respect to accuracy. By combining laser-scanning data with digital imagery, it is now possible to create photorealistic 3D models of buildings and of the terrain with high accuracy. Fully automated generation of dense 3D point clouds, which can be converted to wireframe and texture, are becoming more readily available and boast high-accuracy results. Terrestrial laser scanning in particular can produce dense point clouds from range and azimuth measurements from the ground. The result is very accurate, dense clouds, ideal for BIM (Dowman and Arora, 2012).

Digital surface models have also been widely used to classify and model city data in 3D, through the integration of LiDAR or stereo-imagery with remote sensing images (e.g. Chen et al., 2009, Wurm et al., 2011). Further information about the 3D environment, such as surface materials, can also be derived using hyper-spectral data (Heiden et al., 2007).

In addition, there are a number of mobile mapping systems that have also been developed, which create 3D models through the integration of laser scanning and digital imagery. A state-of-the-art development in this space has been Trimble's Indoor Mobile Mapping System (TIMMS), which can accurately model interior spaces without accessing GPS. The system consists of LiDAR and camera systems engineered to work indoors in mobile mode, computers and electronics for completing data acquisition and data processing workflow for producing final 2D/3D maps and models.

3D Data Visualisation

For simulations to present an accurate picture of the real-world, the accuracy of the geodata used is extremely important and should be based on the latest available imagery (Dowman and Arora, 2012). There is a wide range of 3D city models available today. Both the private sector and government have supported the development of hundreds of 3D virtual cities around the world. The combination of geospatial data and 3D CAD objects has resulted in photorealistic 3D models in a 3D geo-referenced environment.

Software developed from the private sector, such as CityEngine from ESRI, Bentley's Map V8i and Google Earth offer users the capability to create, visualise and measure 3D cities. ESRI's CityEngine is a standalone software

that offers professional solutions to urban planning, architecture, GIS, entertainment and general 3D content production. CityEngine supports the use of geospatial data such as Esri Shapefile, File Geodatabase (GDB), KML, and OpenStreetMap (OSM), allowing users to work with existing GIS features such as parcels, building footprints and street centre lines – when constructing 3D urban landscapes. CityEngine works with a range of 3D formats, including Collada®, Autodesk® FBX®, DXF, 3DS, Wavefront OBJ, and e-on® software Vue. Bentley's Map V8i also offers the tools to visualise smart 3D city models, integrate 3D data from different sources, and key GIS products for creating, managing, and analysing a 3D City GIS model.

CityGML is a common information model for the representation of 3D urban objects (Mao, 2011), and is the first standard related to 3D city models. The model attempts to provide a description of 3D elements such as relief, buildings, traffic infrastructure, water bodies, vegetation or city furniture's with their geometry, topology, semantic properties and relevant attributes. As a result, users are able to implement 3D city models for high-level spatial-temporal analysis in a number of application domains such as urban planning and disaster management. The extensions available in CityGML to adapt different requirements for specific applications make it possible to have enriched 3D city models containing more than mere geometrical elements.

3D Data and BIM

A BIM is a digital representation of physical and functional characteristics of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life cycle, and is defined as existing from the earliest conception to demolition. It offers the ability to model and manage, not just the graphics, but also information that facilitates better and more informed decision-making. It is becoming more and more prevalent to implement a BIM to reduce costs. Making use of BIM eliminates the possibility of data redundancy, data re-entry, data loss, miscommunications, and translation errors (Dowman and Arora, 2012). In the context of the NIMLI, it is of great importance to address the trends that have resulted from organisational bodies endorsing the use of BIM in 3D information management, in order to help reduce the costs involved.

3D Data and VGI

The last few years have witnessed a rapid development in Volunteered Geographic Information (VGI) that has influenced the spatial sciences significantly (Uden and Zipf, 2012). One of the most promising examples of

VGI in 3D city modelling and GIS is OpenStreetMap (OSM) (Goetz and Zipf, 2012). OSM aims to create a comprehensive and free online map with global coverage. Following the collaborative Wikipedia approach, everybody can contribute, edit and improve the data of OSM. It is able to compete against professional data collected by official surveyors or commercial providers (Haklay, 2010).

In Germany, there are currently nearly 5.5 million building footprints available. Compared to the real number of 17.8 million buildings, about 30% of all building in Germany, are covered with OSM. It is likely that in the next 12-18 months nearly all building footprints in Germany will be available in OSM (Goetz and Zipf, 2012).

Figure 2: Heidelberg, Germany in OSM



The results however, are currently building footprints only, without any actual photorealism. In order to create more graphically pleasing models, OSM enables the users to choose building colours, materials and geometries, as well as,

streetlights and trees. There are no current options to import and overlay imagery that will enable photorealistic texturing.

Another prominent example of VGI for 3D data is Google's 3D Warehouse, which allows users to create 3D models that also appear in Google Earth. Google's 3D Warehouse is a shared repository that contains user-generated 3D models from both geo-referenced real-world examples such as churches and stadiums and non-geo-referenced objects such as trees, light posts or interior objects like furniture. The 3D Warehouse models have been integrated into a number of commercial systems such as design tools (RenderLights 2012) or simulation software (Simio 2012) (Uden and Zipf, 2012). Google has also developed a tool called the Building Maker, which facilitates the creation of geo-referenced 3D buildings only. The drawbacks are buildings with potentially low accuracy, however the toolkit allows for non-experts to generate vast amounts of 3D data quite quickly.

Accessibility and Useability of 3D Data

With the vast number of platforms available for the visualisation and analysis of 3D data, it is becoming increasingly important to ensure that users of 3D data can access the 3D data they need without being limited by

the platform they choose or the format they work in. Mobile devices are being introduced widely in society and represent the most attractive solution for access to information anywhere and anytime. However the visualisation of 3D models in mobile devices is a technological challenge because of the size of the models and limited capabilities of mobile devices (Prieto and Izkara, 2012).

Additionally, 3D data should be accessible on the web, with no plug-ins and it should be browser agnostic. Nowadays, it is possible to integrate 3D content on the Web directly into the browser without plug-ins or additional components with WebGL. WebGL is an open standard software library that uses JavaScript to generate interactive 3D graphics on any compatible browser without plug-ins. There are still novel research challenges in this domain to enable users to work any device and obtain 3D spatial information anywhere and anytime. This would be particularly useful in the NIMLI context to advance current access and usability of land information.

Conclusions and Future Recommendations

Moving towards a 3D world has its unique challenges. The advancements in 3D data acquisition, visualisation, access and usability have made it possible to generate 3D virtual environments that can be used for urban planning and effectively managing land. Particular attention needs to be paid to BIM in the land development process, to help reduce costs and increase productivity. With an increase in VGI, users must be aware of limitations to accuracy and completeness of data, while embracing the opportunities of crowd-sourcing information. Infrastructure developed to provide access to 3D data should be accessible on the web with no plug-ins and work on any browser, using any device, to allow for easy access to 3D information of our cities.

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Chapter 9: 3D Visualisation as a Tool to Facilitate Managing Land and Properties

Davood Shojaei

Overview

The rapid population growth and decrease of natural resources have concerned decision makers about land management. Due to the importance of land, methods of land management are being improved to facilitate decision making. One of the important parts in land management system is visualisation that has a direct effect on decision-making processes.

Currently, land management systems in Australia are based on 2D land parcel and each state works separately to manage and visualise land and properties. Due to the silo-based method for managing land and properties, many issues have been raised. For instance, there is gap between the creators of land information at the state level and the users of the information at the federal level (Tambuwala et al., 2012).

In addition to the problems associated to the silo-based approach, Australia suffers from the inefficiency of current systems to manage land and properties. Due to these inefficiencies of storing and representing ownership information in two dimension, the following issues were identified as important challenges in this system: Firstly, all States use 2D visualisation methods such as 2D plans, cross-section and isometric diagrams to display land and associated rights. These methods of representations are not efficient and have limitations to visualise ownership information particularly in complex developments. Secondly, land and properties are managed in 2D and height information is not recorded digitally and functions and queries, which need height information, are not supported. Due to these issues, managing land and properties suffers from many challenges in decision-making processes at a national level. In such systems, uncertainty grows as a result of a non-comprehensive model of the real world.

Due to importance of 3D information for managing land and properties, there is a need for a 3D visualisation system to represent rights, restrictions and responsibilities. Indeed, a 3D visualisation platform is required as a national infrastructure for managing land information by governments at all levels: national, state and territory and local.

This research aims to describe two issues associated with visualisation of ownership information in Australia. Firstly, current problems and limitations of the visualisation approach for land and property information in Australia are described. Secondly, the needs of an integrated visualisation system for the visualisation of land information at a national level, is explained. Then, the status of current land management systems in Victoria is described and some of the issues and challenges attached to the methods of representation in Australia are addressed. Finally some of the applications of an integrated 3D visualisation system at a national level are described and associated issues are addressed.

2D Cadastre

Nowadays, due to the limitation of available natural resources, land value is increasing more and more and as a direct result, new types of interest of land have emerged. These new types are located above or under or even beyond the boundary of parcels, particularly in crowded urban areas (Figure 1). In each year, many multi-level developments, underground structures, high-rises and urban infrastructures such as tunnels, bridges and utility networks are built to provide more spaces.



Figure 1. A sample of structure beyond the parcel boundary in Melbourne, Australia.

Historically, ownership and land rights appeared as soon as an individual, a tribe or a family claimed a right on a specific part of the Earth (Larsson, 1991). At that time, delimitation of rights was utilised based on simple natural characters on the Earth such as rivers, rocks, trees or man-made objects like walls to clarify the limit of the rights. Latter, surveying techniques were developed as a new discipline to facilitate and improve land management. Surveyors could provide services to the owners and governments to determine the border of ownerships on the Earth precisely. Using geomatic science was a big step towards to the new methods of land administration. Surveyors could delimit parcel maps using accurate instruments based on the ownership boundaries, which were named cadastral maps.

Cadastre as an engine of land administration (Williamson et al., 2010) is a tool to record ownership information and cadastral systems incorporating the identification of land parcel and registration of rights, restrictions and responsibilities. Currently, land administration systems are mainly based on land parcels (Kalantari et al., 2008) to record, determine and disseminate ownership information. For more explanation, RRRs are mapped from a 3D environment into a 2D space (parcel map) to represent ownerships in cadastral systems. Due to the limitation of 2D systems, the real world is generalised and recorded in 2D, which is not an appropriate representation of the real world. In addition to limitations of 2D systems, there are some drivers that encourage researchers to investigate a move from a 2D cadastral system to 3D to provide a clear image of the reality. These include:

- The availability of 3D technologies is an important driver. Progress in 3D technologies is very fast in various domains. New technologies for 3D data acquisition (e.g. LiDAR), 3D spatial databases for data storage (e.g. Oracle), and 3D platforms for data visualisation (e.g. Google Earth) are some examples of recent progresses in 3D technologies.
- There is a public demand for more involvement in decision making and the need for an effective means of communication. 3D technologies can communicate more effectively with public.
- Resources are limited and land, as an important resource, deserves modern management approaches for its sustainable use, especially in populated urban areas.

These drivers and current limitations of 2D land administration systems were identified as an important issue, and research was initiated at CSDILA to explore various aspects of developing a 3D land and property information system to improve managing RRRs (Rajabifard et al., 2012). Of the technical aspect (Aien et al., 2011) of 3D land and property information, 3D visualisation of properties and associated rights is the main focus of this research.

3D Visualisation in Cadastre

In cadastral systems, visualisation is considered as a technique to represent the real world. It is a potent communication media and is utilised to convey an image of the real world to users. Therefore, this image should be clear enough to send a true message and intention to viewers.

In a cadastral system, visualisation is one of the most important components. In a 3D cadastral visualisation system, the 3D model of buildings and associated rights has to clearly describe RRRs to communicate with the users efficiently. The benefits of an intelligent 3D cadastre can result in an enhanced communication via visualisation, better decisions, better plans, better designs and better analysis for other related disciplines. A 3D visualisation can serve not only for cadastre and mapping, but also for a wide variety of application fields, like tourism, environment protection, architecture, urban planning, real estate management, urban facility management, navigation, public safety, disaster management, radio network planning, noise emission mapping and etc.

Based on the abovementioned needs for a 3D cadastral visualisation system, many 3D visualisation platforms have been developed recently. However, there is not any specific platform for cadastral applications.

The 3D cadastral visualisation platform must meet a set of requirements that are very important for cadastral applications. These requirements are based on users' expectations in cadastral domain and they are a set of features that are classified into three classes (Figure 2).

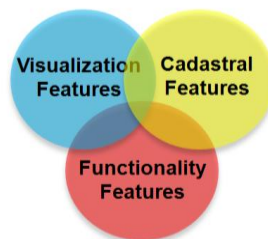


Figure 2. Features classification in a 3D cadastral visualisation system

Cadastral features are important elements in cadastral applications to represent RRRs efficiently and effectively. A 3D cadastral visualisation system would fail if it did not include these features. Visualisation features are used in 3D visualisation systems to improve communication between users and the systems. Functionality features are not related directly to the visualisation domain, but they have indirect effects on visualisation quality.

3D Visualisation at a National Level

In the previous section, some of the issues and challenges were addressed regarding visualising land and properties in 2D. Also current status of managing land and properties in Victoria was described.

In this section, needs of an integrated 3D visualisation system at a national level is described. 3D visualisation can look at ownership information in various scales: building view, city view, state view and national view. At each level, various functionalities and details are presented. 3D visualisation at a national level is required to facilitate policy making for managing land and properties. This visualisation system can visualise ownership information in all states and can answer the queries based on the requirements. In this system, the current delay of providing and visualising ownership information by states will be eliminated and all information will be available for decision makers at once. The users of this integrated system are mostly governmental authorities. However, other parties such as private companies can benefit from this system. For instance, companies that are working on solar panels or utility companies can use this system to make decisions regarding their business at a national level.

The important issues for the development of an efficient visualisation system for managing land information at a national level are addressed below. These include:

- Unique standards and data exchange format for 3D data visualisation: Cadastral data may come from different sources with various data formats and these formats have different visualisation capabilities to store or transfer data among authorities and users. Recently, for spatial data sharing many data formats, such as CityGML, IFC, KML, X3D and LandXML have been proposed and tested in prototype systems. Currently, the ePlan/LandXML has been developed as a digital protocol for the transfer of cadastral data between the surveying industry and government in Australia (ICSM, 2009), but there is not a unique ePlan schema among the states. For example, in Queensland volumetric object is supported in

ePlan schema, while in Victoria it is not covered. Accordingly, there is a need for a unique 3D data exchange format.

- Unique regulations and laws: regulations, laws and terms in various states in Australia are not similar. The methods of preparing subdivision plans are based on states' rules and are different. For example, subdivision plans in Queensland have isometric diagrams for representing properties and buildings, while Victoria only contains cross-section diagrams (see Figure 3).
- Unique process for registration in 3D: there is a need to extend current 2D registration processes to cover 3D property registration. In addition, this process should be similar through the Australia.
- Unique platform and technology for 3D visualisation: there are a wide variety of 3D visualisation platforms; however, a unique platform is required based on the users' expectations.

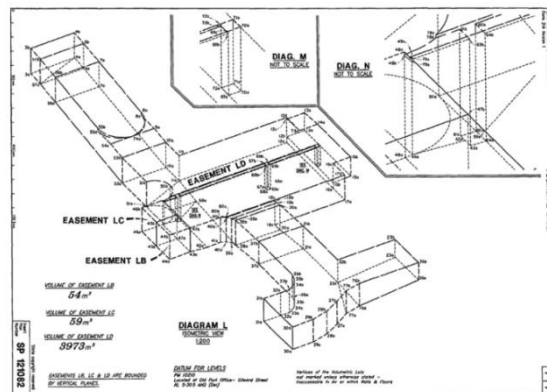


Figure 3: Example of isometric diagram in subdivision plan in Queensland (Döner et al., 2010)

To implement an integrated and comprehensive system to facilitate land and properties, the above issues regarding 3D visualisation need to be considered and discussed further.

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Chapter 10: BIM for Facilitation of Land Administration Systems in Australia

Sam Amirebrahimi

Introduction

With the introduction of the concept of 3D Cadastre and extensive efforts in this area, currently there is a shift from 2D land information management systems to 3D (Stoter & Oosterom, 2006). Research in the context of 3D Cadastre highlights the important role of 3D information about the legal aspects of a parcel (or building) for analysis, as well as visualisation purposes.

This facilitates an efficient management of land/building in the complex environments such as urban context beyond the capabilities of 2D systems. However, currently, the process of land administration in Australia is based on 2D land parcels (Kalantari, Rajabifard, Wallace, & Williamson, 2008) and the input of many processes is still 2D data. As an example, the *subdivision plan* (which contains Rights, Responsibilities, and Restrictions as legal entities to be submitted for title issuance) for a complex building (with multiple ownerships) is extracted from *architectural plans*, which in the majority of cases are 2D CAD files (SurveyorsBoard, 2000).

Building Information Model (BIM), on the other hand, is a fast-growing technology and a promising development in the Architecture, Engineering, Construction and Facility Management (AEC/FM) industry. It is considered as the extension of CAD (Karimi & Akinci, 2010 pp 11), and allows for the development of an N dimensional (nD) virtual model of the facility (e.g. building) by involving many stakeholders (e.g. constructors, surveyors, owners, etc.) to simulate its planning, design, construction and operations/management (Azhar, Nadeem, Mok, & Leung, 2008) throughout its lifecycle (Succar, 2009) (See figure 1).

BIM is three dimensional, data rich and intelligent. The key benefit of BIM is that as a knowledge base, it represents the geometry and semantics of different physical and non-physical aspects of a building (e.g. spaces, units, structural, mechanical, electrical, plumbing, gas and utility systems, scheduling, costing, etc.) in 3D and detailed so that it can be queried and visualised. This enables fast access to reliable information about the building (Zhang, Arayici, Wu, Abbott, & Aouad, 2009) for a variety of applications.

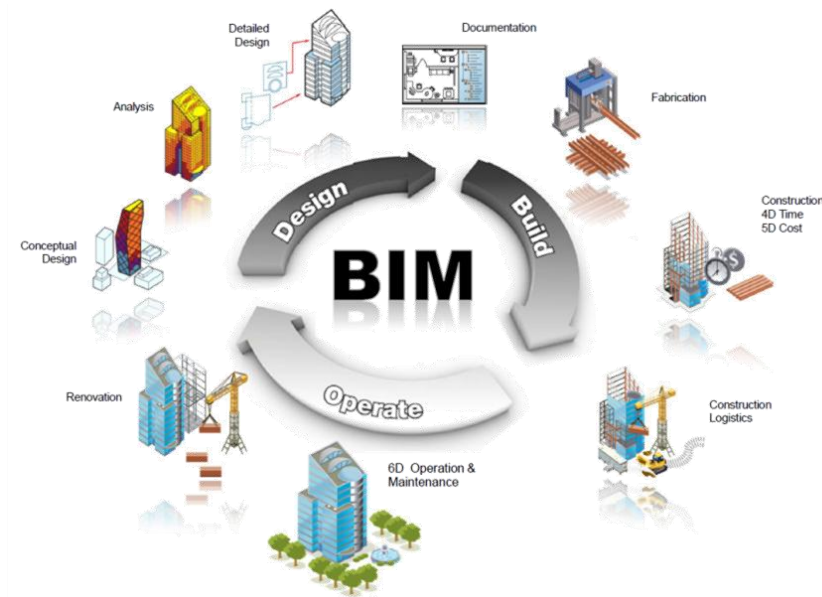


Figure 1: BIM Process Lifecycle (adopted from Pautasso, 2012)

The data about a building stored in the BIM is always consistent and up-to-date throughout its lifecycle. Because of its value, BIM is currently being mandated by many governments around the globe. As an example, Singapore will be fully adopting BIM by 2016 (BuildingSMART, 2012). However, despite the slow rate of adoption of BIM in Australia – 6-16% BIM utilisation will be achieved by 2016 (BuildingSMART, 2012) – significant outcomes in the near future seem promising.

Identification and visualisation of legal information (RRRs) related to a land parcel or a building can be very complex as they exist at different levels of abstraction. However, there is a close relationship between legal objects

and physical objects as discussed by Aien et al. (2011). These relationships may include:

- a) The legal entity is as the same as the physical object itself – or aggregation of number of physical objects or subset of one (e.g. the column as common property).
- b) The legal entity can be an extension of physical object (e.g. the balcony which the legal object can be extracted from the physical object).
- c) The legal entity is bounded by a number of physical objects (e.g. rooms, or units).
- d) Legal object is not related to physical object.

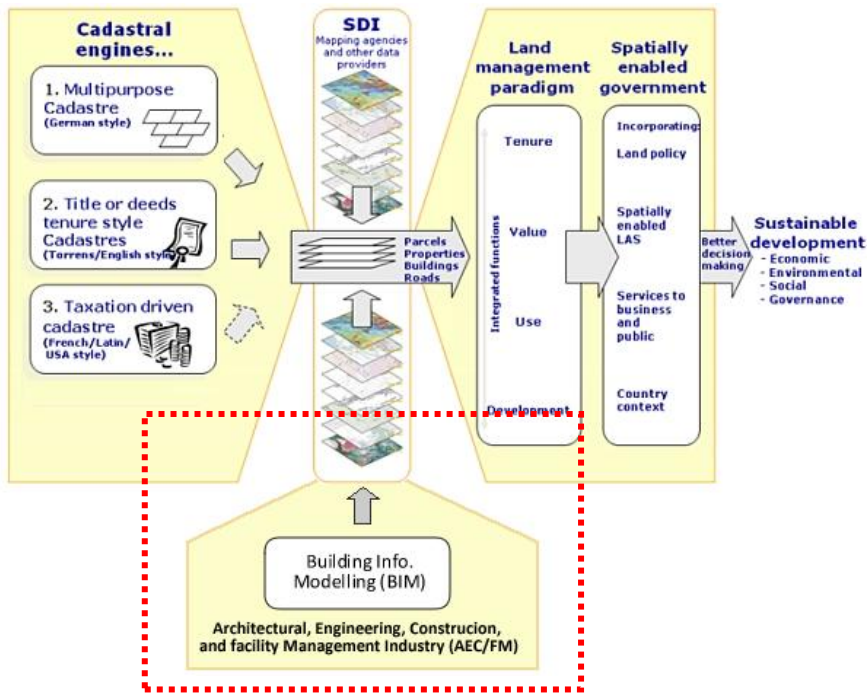


Figure 2: Building Information Model as a new component in Butterfly diagram (Original from Williamson, Enemark, Wallace, & Rajabifard, 2010)

In this way, for the cases (a) to (c), BIM can be considered as a useful technology to facilitate processes in land information management (especially in the complex, dense, and vertically extended urban environment). By being utilised as important input (an up-to-date extensive

3D repository of physical and non-physical information about buildings) to this process, within the context of national, state, or local Spatial Data Infrastructure (SDI), BIM can provide rich information about different physical aspects of the building (e.g. their geometry as well as their relationships) (see figure 2).

With utilisation of BIM in this process, experts can extract legal information from this reliable source by not only considering the architectural aspects of the building but its structure, wiring and cables, pipes, and other systems, which are integrated into a single data repository. Many of these can result in complexity in the analysis and visualisation of ownerships, common properties, or even conflicts as there is a strong interrelationship between these objects – both semantically and physically.

Introducing BIM to Australian land information management brings new benefits in the context of 3D Cadastre research. Its utilisation – instead of 2D architectural plans – will result in avoiding many inconsistencies caused by estimation and creation of 3D information from 2D systems; and a better and more efficient extraction of RRRs and their visualisation within the process of land information management. However, this introduction brings a range of challenges such as institutional, technical, and legal to the process that must be resolved.

This research aims to integrate BIM information as part of SDI in the country at its different levels, which as figure 2 illustrates, facilitating the land management and support sustainable development. For this purpose, this research looks into the integration at data level, which establishes the ground for further integration at higher levels (e.g. processes).

The main findings at this stage include the identification of the main differences between BIM and general geospatial domain data models (in terms of semantics, geometry, and levels of details) currently being used (e.g. CityGML, GML, and LandXML), extraction of criteria for effective integration, and the review and evaluation of existing approaches for this integration.

In the next step of this research, the currently developing approach for the integration will be implemented and tested using a case study. Future directions after successful integration of BIM with National SDI at data level include:

- integration of BIM within the context of SDI at process level using SDI's Service Oriented Architecture structure
- integration of BIM with 3D City Models in order to create an environment for more complex RRR analyses such as taxation based on the 'view' from the apartment, or underground or air resource restrictions, etc.
- testing and validating this integration in the context of an Australian national land administration system.

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Chapter 11: 3D Cadastral Data Model: a Foundation for Developing a National Land Information Infrastructure

Ali Aien

Overview

Australia as a federative country operates separate cadastral and land administration systems in each state and territories. These systems have played a significant role in shaping Australia's development. Initially they provided registration of ownership for land settlement. Then, they assisted in the establishment of a successful and complex land market by providing security for land transfers. They have recently evolved into comprehensive instruments for assisting economic, environmental and social decision making (Enemark et al., 2005).

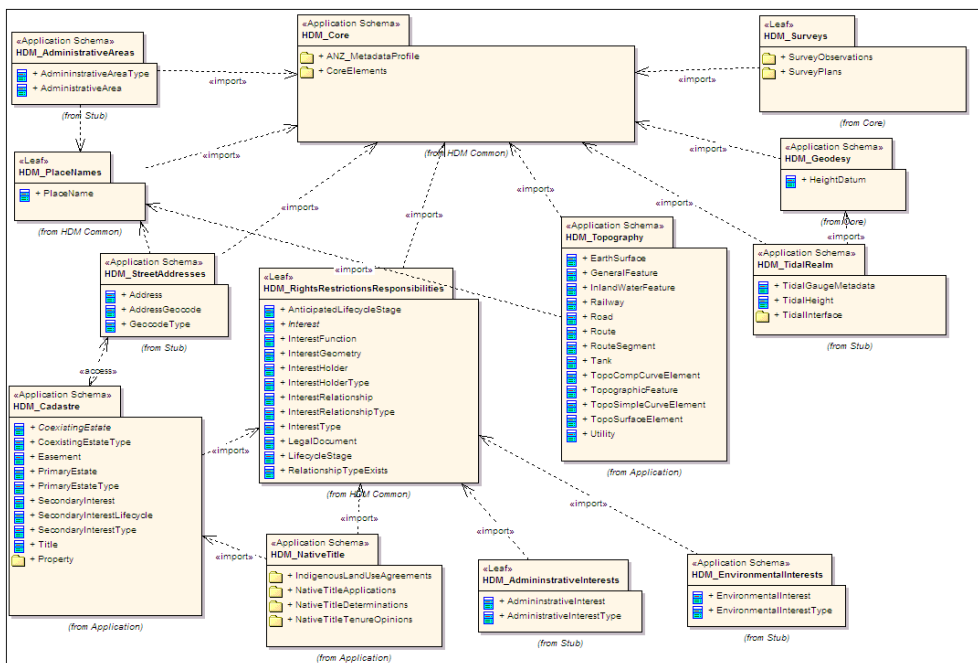
Australia maintains centralised land administration offices in each jurisdiction. There is no approved organisational structure common to all states; land administration is a state government responsibility performed under a range of government departments such as Environment, Planning, Lands or Land Administration (Dalrymple et al., 2003).

Australia is faced with issues that demand a national focus. These issues include natural resource management, land markets, trading in commodities such as water and carbon, and the development of national policies for housing and infrastructure (Marwick et al., 2012).

Land Administration theory either assumes or prescribes the need for a national system. Transformation of disparate land administration systems into an aggregated national land administration infrastructure can deliver multiple purposes and benefits (Bennett et al., 2012).

A move to create national cadastral systems in countries that are federations of states and territories raises many issues. One of the

differences between the jurisdictions is that different states define parcel boundaries differently. In some states cadastral boundaries can move while in others they cannot. The result is that the concept of a land parcel in different Australian jurisdictions varies. The example of the development of the Public Sector Mapping Agencies (PSMA) national data set in Australia based primarily on state and territory DCDBs, together with the commitment to a national competition policy, has raised the concept of national cadastral data sets. Such national cadastral data sets are key components of any future national land administration infrastructure (Ting & Williamson, 1999).



Another example is the ePlan data model. In 2003 the ePlan working group was formed by ICSM to develop a national digital cadastral data transfer standard. The ePlan working group has now developed a model to produce

a generic subdivision data format based on LandXML, an internationally accepted standard for cadastral plan data, which includes jurisdictionally specific elements. The ePlan model accommodates all of the survey geometry and administrative and titling data required to process a plan of subdivision from its initial preparation by the surveyor through to its lodgement with council for certification and subsequent registration by Land Victoria and entry in the Digital Cadastral Database (DCDB) (Kalantari et al., 2009).

The ePlan Model is a set of UML Class diagrams that describes the data contained within a cadastral survey. This model is the logical model of the cadastral survey and was initially used to give an understanding of the model from a surveyor's perspective. It inherits the ISO standards and rules of Australia's Harmonised Data Model (HDM). This model has been classified into a number of packages. They are: Document, Surveyor, Survey, Parcel, Address, Geometry, Point, and Observation (Figure 2).

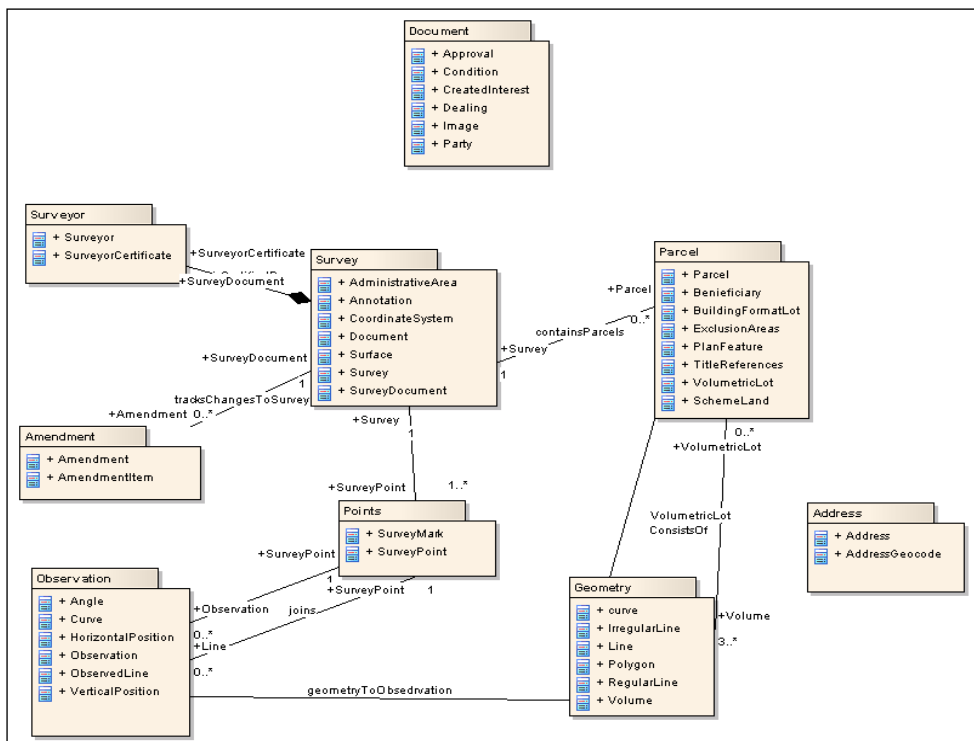


Figure 2. ePlan Model packages (ePlan, 2010)

The current ePlan protocol has been exercised rigorously over the last several years primarily with the traditional 2D survey world. The ePlan model has been designed to support 3D surveys, which include Volumetric and Strata (Building) surveys. These types of surveys can be prepared with the current protocol but have not been fully exercised. A challenge of the 3D world is developing business routines for testing and verifying 3D objects. It is a fairly simple test for accuracy of 2D parcels, for example, does the parcel close, but in the 3D world, tests for planarity and the completeness of the solid become more challenging (Cumerford, 2010).

ePlan is serving very well for 2D cadastre; however, having only VolumetricLot and BuildingFormatLot as attributes of ePlan's Parcel class (Figure 2) to support Volumetric and Strata (Building) surveys, is not enough to support the requirements of 3D cadastre, which will be described in the next section.

3D cadastres would assist management of 3D RRRs. A 3D cadastre should be capable of storing, manipulating, querying, analysis, updating, and supporting the visualisation of 3D land rights, restrictions and responsibilities (Aien et al., 2012).

Need for a 3D Cadastral Data Model at the National Level

The needs for developing a 3D cadastral data models are described below:

- best practice guidelines and standards for implementation of a 3D cadastre
- establishment of conceptual framework for a 3D cadastre including the key components and their relationships that will support the subdivision of buildings and strata developments
- organisation and provision of documents and practical guidelines for land surveying professionals
- promotion of standards and a common language within the land administration user communities
- foundation of a 3D cadastre database
- facilitation of the exchange of data and the integration of similar datasets, and ease data sharing and interoperability
- understanding data requirements of involved parties
- extension/enhancement to the ICSM HDM cadastral theme and ePlan data model incorporating the 3D components.

Requirements of 3D Cadastre

The research strategy for determining the requirements for the 3D cadastre is to assess the needs of user communities. This information is summarised below. It is based on: the survey conducted by the members of the Intergovernmental Committee on Surveying and Mapping (ICSM) of Australia/New Zealand (ICSM, 2007); the discussions in the collaborative research workshop on *Land and Property Management in 3D*, at the University of Melbourne, Australia, 2011; and from the observations in the *2nd International Workshop on 3D Cadastres*, Delft, The Netherlands, 2011. The results are grouped together to summarise the requirements.

Current Registration of 3D Properties

- Most of the jurisdictions currently accommodate 3D properties in cadastral registration, using 2D survey plans, diagrams, and textual references to the third dimension, but 3D land developments are increasingly complex and difficult to interpret.

Function of 3D Cadastre

- A 3D cadastre should be able to unambiguously define real property interests in land and air space.
- A 3D cadastre can assist management of multipurpose land, and in time will become an essential base layer for all land administration functions such as land tenure, land value, land use, and land planning.

3D Data Acquisition

- Surveying systems and control networks allow 3D definition of property objects.
- Coordinated ground survey is identified as the main form of obtaining data for 3D cadastres.
- The other forms of data collection are also generally recognised as appropriate data collection methods such as uncoordinated ground surveys and measurements, aerial imagery, digitised historical records, depending on the accuracy requirements and circumstances.
- Architectural and engineering plans and as-built drawings are also highlighted as additional sources of relevant data for 3D cadastres.

Rights, Restrictions and Responsibilities

- All 3D cadastres should record at least the same rights as their 2D counterparts.

- All interests in land should be the ultimate goal and recorded in 3D cadastre.
- There is strong support for more transparency in records of public law restrictions. An extensive list of items now cannot be captured and result in an incomplete and misleading datasets.
- Property use should be recorded in a 3D cadastre.

Interest holder information

- All title and ownership information (land registry information) should be recorded in a 3D cadastral database.

Geometry and Topology

- The 3D cadastral database must contain all information of the survey plans. 3D topological structure is an ultimate goal for 3D cadastre.

Accuracy and Reliability

- Standards for accuracy and reliability should be created collaboratively in response to public and private needs.
- Data integrity, common standards and a single, consistent source of information should be considered in a 3D cadastre.
- Accuracy and reliability of a 3D cadastre should have a legal mandate.
- Data providers for a 3D cadastre (e.g. surveyors, conveyancers) are responsible for the accurate and reliable information.

Time

- The 3D cadastral database should contain all temporal information of land transactions, legal and physical changes, and re-survey measurements and observations.

A 3D cadastral Data Model (3DCDM) was developed based on these requirements of a 3D cadastre. Additionally, utilisation of the experience and advantages of the current cadastral data models were taken into account. However, the investigation of requirements should be extended to better meet the needs of user communities. The 3DCDM is proposed in detail in the following section.

3D Cadastral Data Model (3DCDM)

A 3D Cadastral Data Model (3DCDM) was proposed at the 2nd *International Workshop on 3D Cadastres* (Aien et al., 2011). Since that time, the data model has been modified and improved to meet the gathered

requirements of the 3D cadastre. Temporal aspects of an interest holder, property object, and survey information are added to the data model to support updates in the database. The data model will normally adapt the entity types, attributes, relationships, integrity rules, and the definitions of those objects used in 3D cadastres. It reflects the experiences and advantages of the existing cadastral data models. ePlan Model can be extended and developed based on the findings of the 3DCDM to support requirement of 3D cadastres.

Requirements of the 3D cadastre can be summarised into the following. This information gathered based on the survey conducted by the members of the ICSM, discussions in the collaborative research workshop on *Land and Property Management in 3D*, at the University of Melbourne, Australia, and from the observations in the *2nd International Workshop on 3D Cadastres*, Delft, The Netherlands:

- Title and ownership information (3DCDM_InterestHolder)
- Legal and physical information of 3D objects (3DCDM_PropertyObject)
- Geometrical and topological information (3DCDM_Geometry)
- Survey administrative information (3DCDM_Survey)
- Survey point information (3DCDM_SurveyPoints)
- Survey measurements and observations information (3DCDM_SurveyObservation)
- Other forms of data collection, engineering and architecture maps (3DCDM_ExternalSources).

According to the requirements, 3DCDM consists of seven packages. They are: 3DCDM_InterestHolder, 3DCDM_Propertyobject (PO), 3DCDM_Geometry, 3DCDM_Survey, 3DCDM_SurveyPoints, 3DCDM_SurveyObsevation, and 3DCDM_ExternalSources. UML class diagram is used to develop the data model (Figure 3).

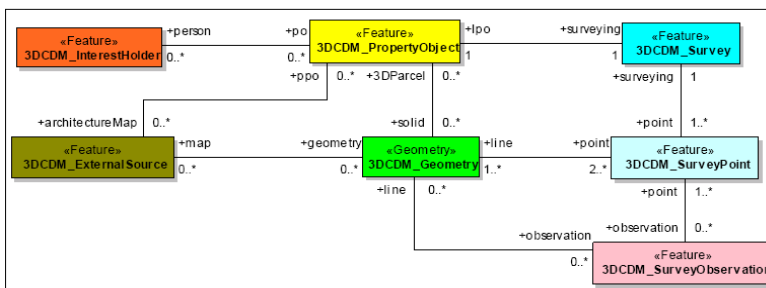


Figure 3. Core classes of 3DCDM

Contribution and Future Directions

This research defines a 3D cadastre as a tool in a land administration system that enables better management and registration of multiple stratified land rights, restrictions and responsibilities in 3D space. Furthermore, it is indicated that legal aspects (legislation to support 3D property registration), institutional aspects (relationships between involved parties), and technical aspects (technical support to realise 3D cadastre) of 3D cadastre should be considered in the implementation of 3D cadastres. Specifying the domain of 3D cadastre concludes that 3D cadastres do not need the amount of detailed information that is required in 3D city models. All these discussions and proposed 3D Cadastral Data Model (3DCDM) helped to provide a framework to identify the structure of the 3D cadastre and clarify its scope.

The Core Cadastral Data Model, New Core Cadastral Data Mode (based on Legal property Object), ePlan, and LADM were assessed to enrich the 3DCDM. The 3DCDM utilises the advantages and experiences of these data models. The concept of the Legal Property Object is the base of the 3DCDM. Geometrical and textual information of survey plans are represented in the 3DCDM such as ePlan and LADM; however, it attempts to model physical objects of architectural and engineering plans in a three-dimensional space. The 3DCDM supports temporal aspects of the spatial and descriptive information.

The 3DCDM has seven packages to meet the specified requirements. The 3DCDM identifies the major objects, attributes, and constraints of the 3D cadastre and how they are arranged. Time is considered to maintain the temporal changes of cadastral objects in the 3DCDM. It also provides documents and guidelines for land surveyors to recognise what type of data they should acquire. The 3DCDM is a good starting point to develop the 3D cadastral database.

Further research is required to validate the model and examine approaches to implementation. Also, there is a requirement to consider the role of BIM and IFC in 3D cadastral data modelling. This would enable utilisation of the concept and terminologies of the existing related standards such as LADM, to categorise the level of requirements (general and specific requirements), and to investigate how legal and institutional aspects affect both legal and physical objects.

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Chapter 12: Facilitating the National Infrastructure for Managing Land Information (NIMLI) through Spatial Metadata Automation

Hamed Olfat

Introduction

As part of the National Infrastructure for Managing Land Information (NIMLI) research project, Tambuwala et al. (2012) proposed a national land information lifecycle model that includes five main stages: collect; store and maintain; share; use; and dispose or archive. Among these stages, 'share' refers to the entities and inter-governmental process and services that disseminate information. For instance, in the context of Australia, PSMA¹ is involved in the 'share' stage of the information lifecycle and currently shares the CadLite and G-NAF datasets with Commonwealth Departments.

In order to facilitate sharing the information within the national land information lifecycle there is a need to provide and maintain complete, up-to-date, and precise metadata for shareable land-related datasets. Metadata, commonly defined as 'data about data' (ANZLIC 1996, Zarazaga-Soria et al. 2003), plays a critical role in any spatial data sharing platform (Ezibalike and Rajabifard 2009, Rajabifard 2007) of which the aims are to simplify data sharing, discovery, retrieval and access.

However, the current approaches cannot effectively manage metadata creation, updating, and improvement for an ever-

¹ Public Sector Mapping Agencies Australia Limited

growing amount of data created and shared in the sharing platforms, particularly within the national infrastructures for land information, due to the huge amount of data involved and updated in short time frames. Metadata is commonly collected and created in a separate process from the spatial data lifecycle which requires the metadata author or responsible party to put extra effort into gathering necessary data for metadata creation (Olfat et al. 2012c).

Metadata and related spatial data are often stored and maintained separately using a detached data model (Kalantari et al. 2009). This issue results in avoiding the automatic and simultaneous metadata updating when a dataset is modified (Rajabifard et al. 2009). In addition, the end users are disconnected from the metadata creation and improvement process and there is a need for more interaction with the end users within the data catalogue systems (Kalantari et al. 2010).

With this in mind, investigation of the feasible automatic approaches for creating, updating and improving the content of spatial metadata applicable to any level of spatial information infrastructure (e.g. the national infrastructure for land information) is central to the 'Spatial Metadata Automation' ARC² - Linkage Project. This project is coordinated by the researchers from CSDILA, at the University of Melbourne in conjunction with industry partners including the Victorian Departments of Primary Industries (DPI) and Sustainability and Environment (DSE), the Land and Property Management Authority (LPMA) – NSW, Emerg, CubeWerx, and Logica Pty Ltd.

This chapter explores the framework and technical solutions designed, developed and evaluated within the spatial metadata automation research project for addressing the main challenges regarding the metadata management mentioned earlier in this section.

Spatial Metadata Management Framework

The spatial metadata management framework developed in the research project includes three complementary approaches namely 'lifecycle-centric spatial metadata creation', 'automatic spatial metadata updating (synchronisation)', and 'automatic spatial metadata enrichment', and an

² Australian Research Council

integrated data model for spatial data and metadata storage and delivery, as illustrated in Figure 1.

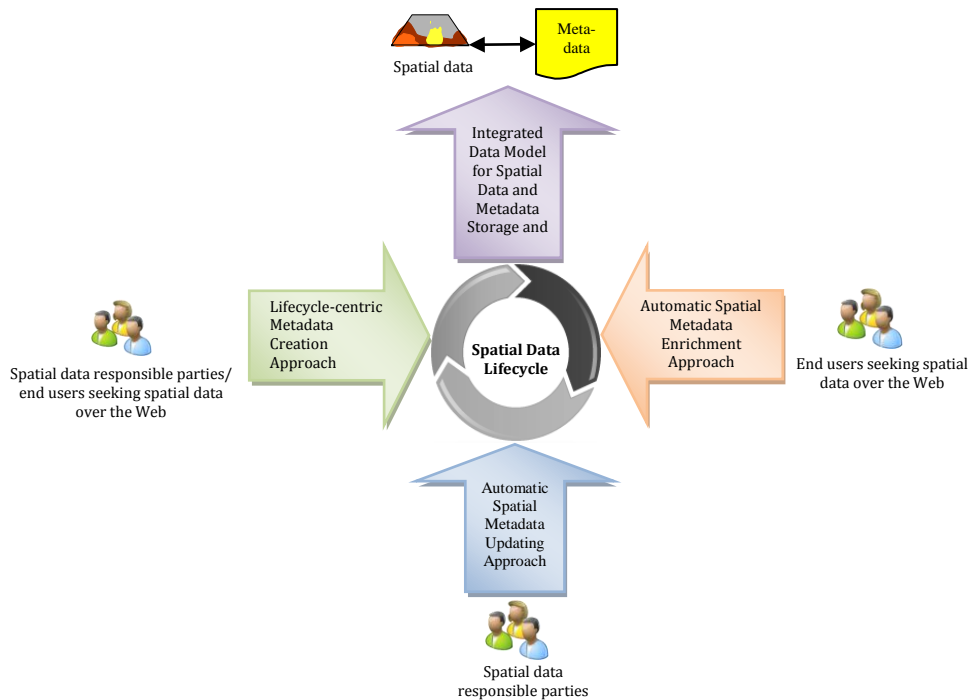


Figure 1: Spatial metadata management framework

The components of this framework are explored as follows:

Lifecycle-centric Spatial Metadata Creation Approach

The ‘lifecycle-centric spatial metadata creation’ approach identified the ISO 19115: 2003 metadata elements that needed to be created within any step of the spatial data lifecycle. In this regard, a generic spatial data lifecycle was designed and employed by this approach. The generic lifecycle consisted of eight steps including: planning and policy making, data collection, spatial dataset creation, storage, publication, discovery and access, utilisation, and maintenance (Olfat et al. 2012c).

It was also realised that the highest number of ISO 19115: 2003 metadata elements should be created within the spatial dataset creation step. Planning and policy making, dataset maintenance, publication, data collection, dataset storage, utilisation, and discovery are respectively the next steps with the highest number of elements. The research showed that

using the lifecycle-centric spatial metadata creation approach the metadata could be completed over time in conjunction with the spatial data lifecycle and therefore, it would be more likely to be accurate and up-to-date.

Moreover, it was deduced that the proposed approach has the potential to reduce the burden of metadata creation for metadata authors by involving the spatial data responsible parties and interacting with the end users in creating and updating metadata values.

Automatic Spatial Metadata Updating (Synchronisation) Approach

The ‘automatic spatial metadata updating (synchronisation)’ approach focused on automating the process of updating a subset of ISO 19115: 2003 metadata elements (including bounding box, lineage statement, date of revision, and metadata date stamp) whenever the vector dataset was modified, regardless of the dataset format (Olfat et al. 2010, Olfat et al. 2012a). The research identified a number of technical requirements to develop such a new approach.

The main requirement was an integrated data model built upon Geography Markup Language (GML) technology for storing and delivering the spatial metadata and dataset jointly. A mapping software application to generate the integrated data model and support dataset and metadata updating; a user-friendly interface to view the dataset and metadata from an integrated data model and then modify the dataset; and synchronisation scripts to update metadata based on dataset changes; were also the other technical requirements considered for implementing this approach.

In order to prove the metadata synchronisation concept, a prototype system based on the open source environments (GeoNetwork, deegree, PostGIS, PostgreSQL, OpenLayers, GeoExt, etc.) was implemented and evaluated in this research. Figure 2 illustrates the prototype system user interface.

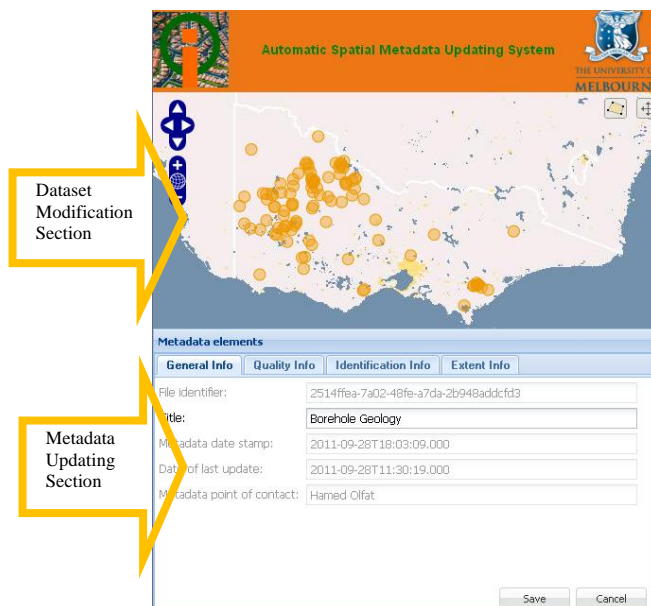


Figure 2: Automatic spatial metadata updating prototype system user interface (Olfat et al.2012a)

Automatic Spatial Metadata Enrichment Approach

The 'automatic spatial metadata enrichment' approach concentrated on Web 2.0 features (folksonomy and tagging) to involve the end users seeking spatial data to improve the content of 'keyword' metadata element. The research designed two complementary models (Kalantari et al. 2010).

The first model, namely 'indirect', monitors the end users' behaviour against the retrieved metadata during the data discovery process and records the search words that were relevant to the datasets (based on a weighting system), and finally assigns the popular search words to the metadata 'keyword' element.

The second model, namely 'direct', allows the end users to tag a dataset with words they feel best describe what it is about, and agree/disagree with the relevance of their used search words or formerly tagged search words (by previous users) to the retrieved metadata.

In order to prove the metadata enrichment concept, a prototype system was implemented and evaluated within two different environments: GeoNetwork as an open source spatial data catalogue application and

Model Information Knowledge Environment (MIKE) by DPI – Victoria as an example of data product – data modelling environment (Olfat et al. 2012b).

Conclusion and Recommendations

The spatial metadata automation research project designed, developed and evaluated a framework that facilitates and automates the creation, updating and enrichment of the content of metadata for shareable datasets. This framework has the potential to be applied to the national infrastructure for managing land information (NIMLI) to assist the stakeholders in sharing, discovery, and access of land-related datasets.

The research highly recommends that the process of metadata creation needs to be integrated with the land information flow lifecycle to provide complete, up-to-date and accurate metadata. It also suggests that the land-related dataset and its associated metadata should be stored together using a GML-based integrated data model, so that managing and maintaining both metadata and datasets can be undertaken in real time. Finally, the research recommends that involving the end users of a national land infrastructure in the process of metadata creation and improvement would facilitate the data discovery and improve the usability of discovery services.

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Chapter 13: North West Melbourne Data Integration Project

Serryn Eagleson

Introduction

Over the past ten years Melbourne has consistently ranked as one of the most liveable cities in the World (Moore 2012). However the Victorian Government and researchers from the University of Melbourne have recognised that liveability in the North West Melbourne is under threat. The population in the area is growing rapidly and is forecast to increase by over five hundred thousand people in the next 10 years (1,662,500 to 2,183,700) (DPCD, 2012). Recognising the significant challenges that this population growth will have on the liveability the North West Melbourne Regional Management Forum (NWM – RMF) has identified the need to work collaboratively across government, academia to develop an integrated spatial data platform to support research in the region.

The value of this project will be shown through the development of the integrated data platform along with four demonstrator projects that cover the most pressing issues facing the region: walkability, employment clustering, housing affordability and health services. Improving these problems is of critical importance to these communities. However it is recognised that they are not single issues that can be readily solved in an isolated study. There are many interacting systems with complex interplays, which require an integrated approach to plan solutions to the problem.

Background

The project has a strong Victorian Government connection provided through the North West Melbourne RMF; the NWM-RMF was established in 2007 as a resource to strengthen advocacy platforms. The RMF has a mandate to share data with the intention to guide policy decisions and collaborate in integrated planning activities across the North West Melbourne. Members of the RMF include government secretaries from across the Victorian Government and Chief Executive Officers from each of the fourteen local governments across the area. Figure 1. provides an illustration of the North West Melbourne, which includes 14 local government areas.

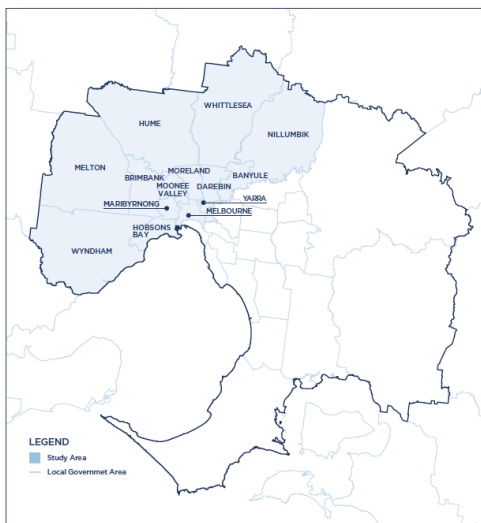


Figure 1: North and West Metropolitan Region of Melbourne

This initiative builds on several of the key strategic directions identified by the NWM – RMF, which is working collectively across government and academia. This project recognises that by using web enabled technology for connecting computers, data exchange and integration can take place enabling multi-disciplinary research teams to provide an evidence-based approach to decision making. The project is being supported by the Australian Urban Research Infrastructure Network (AURIN) and the Australian National Data Service (ANDS) both of which are funded by the Australian Governments Super Science scheme to provide the infrastructure to facilitate access to a distributed network of datasets.

Figure 2. provides a level project design illustrating the relationship between data custodians, the AURIN portal and RDA. Developing a system that is able to connect data custodians and provide both data and metadata into AURIN, as well as Metadata records to Research Data Australia (RDA), is central to the project. Four demonstrator projects have been developed to demonstrate the value of the integrated data hub. The outputs and outcomes will be specific to each demonstrator; however, generally they are operating towards a similar goal of supporting liveability in the region. All demonstrators will identify a wide range of datasets for the North West Melbourne Corridor, which will be made available through a 'data hub'.

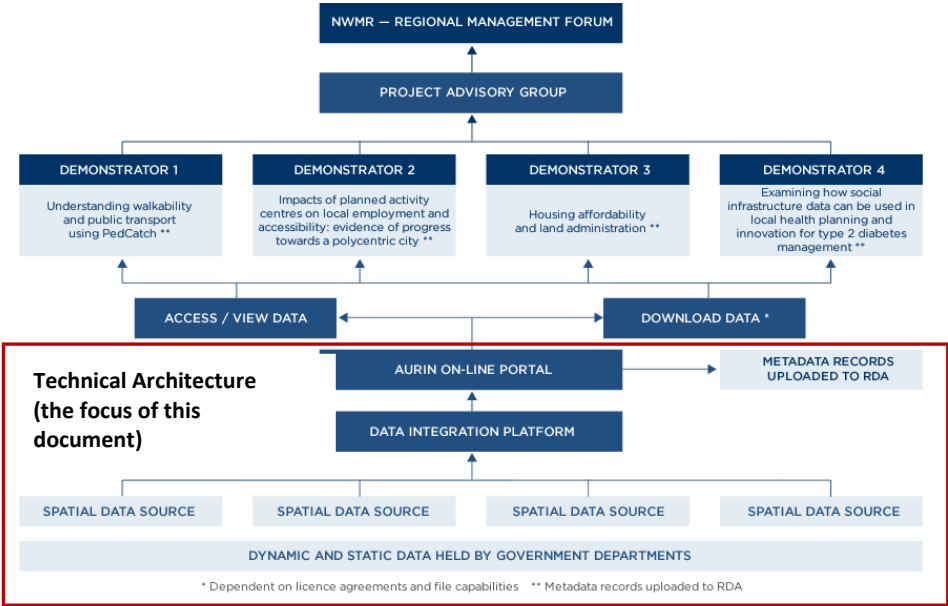


Figure 2. Structure of the data integration project.

This data will also aim to test the metropolitan planning policies in operation across the region, the following section highlight the policies in the region.

The data hub will provide access to a number of datasets to researchers via the AURIN portal. Each demonstrator will provide static outputs of their work, or provide additional functionality via the writing of code to facilitate dynamic query of supplied datasets using specifications as supplied by AURIN. The data hub (including data integration and interrogation capability) will be used to highlight the potential in unlocking and

integrating data to focus on an evidence-based approach for researchers and authorised users.

Software and data validation and integration tools will be developed to synthesise the various datasets to demonstrate value to all project stakeholders (the concern of ANDS). The project includes four demonstrators, each focussing on key policy questions relating to the urban environment issues identified by the NWMR-RMF. Specifically this project will demonstrate how a data hub together with innovations in software for data analysis can be used to support policy and decision making across a number of liveability lenses, being the: built environment and health, housing affordability, economic productivity, and transport and sustainability.

The following summary provides an overview of the aims and objectives of the demonstrator projects:

Demonstrator 1: Walkability Demonstrator Outcomes

Walking is one of the most beneficial forms of exercise. Planners are increasingly in need of spatial tools to map walking paths and improve coverage through the street network. This project aims to provide an online agent based pedestrian catchment modeller delivered via web-based mapping tool. The tool will include a scenario testing functionality to enable planners to change the street network and upload more detailed data such as footpaths. Two study areas have been chosen for this project one in inner Melbourne and one in the Shire of Melton.

Demonstrator 2: Employment Demonstrator Outcomes

Production of gravity and cluster-method based web-mapping tool. This tool will use gravity and clustering methodologies to understand the formation of overall sector-specific job clusters. Data will be drawn from the ABS journey to work and Department of Transport (Victoria). It will provide an evidence-based data source to better understand clusters, commuter and firm response to clustering policies, and ultimately clustering dynamics (commute changes and job growth). Outcomes from this project will be made available to stakeholders in State government and available via the AURIN portal.

Demonstrator 3: Housing Affordability Demonstrator Outcomes

Production of a dynamic web-mapping application aimed at generating a Residential Development Potential Index (RDPI) for the North West Melbourne Region. Tools developed for further reporting on this RDPI will

include reporting and analysis outcomes. Analysis tools include: econometric, land as a function of housing affordability, urban intensification, housing development, change of use, spatial analysis and analysis of development approvals.

Demonstrator 4: Health Demonstrator Outcomes

Production of a dynamic ecological web-mapping tool to combine diabetes and disadvantage indicators to provide 'heat map' concentrations of combined need. The tool will compare the outputs from first tool to the distribution of diabetes and primary health care services. These tools will be made available via the AURIN portal and the metadata made available via the RDA. The tool aims to identify areas of particular vulnerability and combine these outputs with social and physical infrastructure data based on CASE-D Study data. Reporting and academic outputs will conclude the program, which aims to highlight the importance of data integration in interrogating any apparent associations between data sets. These results will be presented to Medicare Locals, scientific conferences and other key stakeholder groups. All outputs will be made available via the AURIN portal.

Conclusion

This project aims to bring together datasets into a common platform for enhancing research and policy outcomes, as well as collaborating with state government and data custodians. The framework development has been endorsed by the Victorian Government and represents an exemplar in terms of broad participation with five departmental secretaries (CEOs) giving written support to the project.

The demonstrator projects have been selected based on prior consultation with state government agencies to identify policy areas which need attention. The 12 month time span of the project is a timeframe in which the projects can input directly into the policy objectives.

Technically the infrastructure to be developed will be based on an open source platform, which enables access to the distributed datasets maintained by Victorian Government departments and linked with broader national data and research through the national priorities of AURIN and ANDS.

Acknowledgements

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RESEARCH SNAPSHOT



This publication highlights the importance of a national land administration infrastructure to support sustainable development. It contains a summary of research connected to the national infrastructure for managing land information project funded by the Australian Research Council Grant (LP0990571:2009-2012). This summary also covers other related research conducted over these last four years.

The projects identifies the drivers and components required for better management of land and property at a national level for Australia and makes recommendations for similar federated countries.

The research project has been coordinated through the Centre for Spatial Data Infrastructures and Land Administration, the University of Melbourne in close collaboration with industry partners.

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Centre for Spatial Infrastructures
and Land Administration
Department of Infrastructure
Engineering
The University of Melbourne
Victoria, 3010, Australia



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