SPATIALLY ENABLED LAND ADMINISTRATION; PARADIGM SHIFT IN LAND INFORMATION MANAGEMENT

ABBAS RAJABIFARD, MOHSEN KALANTARI and IAN WILLIAMSON
Department of Infrastructure Engineering, University of Melbourne, Australia
abbas.r@unimelb.edu.au
saeidks@unimelb.edu.au
ianpw@unimelb.edu.au

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Abstract
The administration of land is challenged by the increasing need of clients for land information and by the creation of new land related commodities and interests. In this space, spatial information and technologies can change the way business and governments manage activities and solve problems in relation to land. 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. These emerging spatial technologies potentially expand the capacity of societies. 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. Building on the growing need for land information and availability of spatial technologies, this paper presents two paradigm shifts in collecting and managing land information in the context of spatially enabled land administration.
1. Motivation and Background

Land is an ultimate resource without which life cannot be sustained. From a social point of view, land facilitates many functions in a society, from very basic activities like obtaining food, water and making shelters, to creating complicated infrastructures like telecommunication and power stations. From an environmental perspective, survival of many species depends on land. From an economic standpoint, land is the most important asset people possess; a foundation on which wealth is built.

However, the administration of land is challenged by the increasing need of clients for land information and by the creation of new land related commodities and interests. In this space, spatial information and technologies can change the way business and governments manage activities and solve problems in relation to land. 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. These emerging spatial technologies potentially expand the capacity of societies. 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. Building on the growing need for land information and availability of spatial technologies, this paper presents two paradigm shifts in collecting and managing land information in the context of spatially enabled land administration. First one is AAA Land Information and second one in the need for Land and Property information in 3D.

2. AAA Land Information

The concept of AAA land information described in this paper arose from research from an Australian Research Council Linkage Project titled “A National Infrastructure for Managing Land Information (NIMLI)”. The project is being undertaken by the Centre for SDIs and Land Administration at The University of Melbourne. Project partners include the land registries of the Australian states of New South Wales, Victoria, and Western Australia, and the Public Sector Mapping Agencies of Australia Ltd (PSMA). The research focuses on the role of land registries in underpinning macro-economic management, housing provision, and the organization of rights, restrictions and responsibilities (RRRs) information. The NIMLI project can be seen as another starting point for enabling a national approach for land registries and better use of their collected information in Australia.

The project describes the needs of a modern information society that can be summarized as:
Having national drivers – the economy, the environment, a just society, defence, governance, emergency response and many more

The ability to model and manage both the natural and built environment

The creation, recording and managing all RRRs (rights, restrictions and responsibilities) relating to land

Building a virtual model of any jurisdiction or country

Central to a modern information society is a spatially enabled society (SES) and spatially enabled government (SEG) that can be described as:

An evolving concept where *location, place* and other spatial information are available to governments, citizens and businesses as a means of organising their activities and information

Simply, SES is about *managing information spatially, not managing spatial information*

*Transparent or ubiquitous* use of spatial information, so much so that the vast majority of users do not know they are “spatially enabled” – and don’t care!

And with spatially enabled government being:

A concept with the same principles as SES but applied to *management and delivery of government services* - part of e-government initiatives

Applied in a “*whole of government*” approach

Vertically through *all levels of government*, local, county, state or provincial and federal (where countries are federations of states)

And meeting organisational and institutional challenges where *large scale parcel level data* is managed at either local, county or state level, but needed for national scale activities and institutions

The key to SES is the property base or, for the initiated, the cadastre. The property base connects people to land. However a holistic approach is required to integrate the cadastre, land administration, national geocoded address files and spatial data infrastructures. Importantly the cadastre is the core of large scale SDIs.

As background online spatial data¹ are being widely used by citizens, government and the private sector in a variety of applications and domains such as business, navigation, properties/parcels and street

¹ The term “spatial” encompasses geospatial, spatial, geographic and land data/information
address. However public and private businesses often assume online spatial data are just maps and these maps are accurate. They do not appreciate how and by whom this spatial data are created, collected, maintained and updated. In the past was not been a critical issue since spatial data were generally produced and updated by authoritative government agencies.

This landscape is dramatically changing with the introduction of crowd sourced and Volunteered Geographic Information (VGI) whereby members of the public or wider society can collect and contribute to the sources of much spatial data. This VGI phenomenon has enabled a wealth of free spatial information such as street address, land parcels/properties and road networks to be created and maintained by an untrained public at various levels of integrity and accuracy. As a result, companies (e.g. Google) that maintain online maps, tend to use free crowd sourced spatial data instead of authoritative sources of spatial data. Government and particularly land administration agencies such as by the Public Sector Mapping Agencies of Australia usually produce these forms of high quality and high integrity spatial data however they are commercially expensive, reflecting the efforts needed for their construction, maintenance and further development.

Another way of understanding the differences between AAA land information and VGI is with the use of the spatial data continuum from a quality and fitness for purpose perspective as shown below (Figure 1). The continuum starts with VGI with lower quality and ends with AAA land information with the best possible quality. The continuum also highlights the advantages and disadvantages of VGI and AAA land information. The data in VGI is sourced from citizens and AAA land information is sourced from government LAS, primarily land registries. In between, spatial data with different levels of quality and integrity is created by the private sector, non-government agencies, local governments and mapping agencies.

The continuum is informed by a set of criteria for evaluating spatial information including lineage, positional accuracy, attribute accuracy, logical consistency, completeness, semantic accuracy, usage and temporal quality (van Oort, 2005). Among the criteria, lineage plays a significant role in helping the users in assessing the suitability for a particular use. Even though the spatial data quality can be improved, understanding its fitness for use is a significant challenge for the users. As a potential solution, a well-compiled metadata that explains lineage plays a critical role in describing its fitness for use (Kalantari et al., 2010).
Recognizing this changing environment of the spatial industry, we highlight the significant impact of land administration systems (LAS) on spatial data quality and emphasize the importance of tenure, ownership, property boundary and street address data created in these government LAS usually within land registries, in the growing world of crowd sourced and VGI. Spatial data created in LAS is defined as AAA rated land information that is Accurate, Assured and Authoritative. Importantly AAA land information has a documented and legally valid audit trail that is a key to good land governance and land information management.

Importantly land professionals (surveyors, valuers, building surveyors, planners and land administrators) create, maintain, manage and provide access to this information as part of their routine activities. They have key responsibilities of creating, recording, maintaining and improving AAA land information.

In order to fully understand AAA land information it is useful to remember the traditional roles of land registries, that delivered the land administration functions of registration and parcel identification that produced high quality and high integrity information, often guaranteed by government (AAA land information). However land information within land registries is usually not spatially enabled, especially nationally. The tools to spatially enable land information nationally (geocoded national address files and national cadastral data bases) are not key tools in land registry administration. In addition owner information in land registry data must be improved – name changes, address changes and identity
checking are relatively poor and need to be thoroughly upgraded on a national scale. There is no doubt that within the traditional land registries, land information is an underutilized public asset.

A key objective for all countries and especially those that are federations of states is to awaken the land registry “sleeping giants”. However land registry data is different from most spatial data. It is:

- Essential for land markets and the wider economy
- Legally authoritative
- Insured by government
- Spatially accurate (cadastral verification)
- Highly dynamic
- Maintenance intensive
- Large scale
- Central to the business model of the registry
- Sensitive in terms of privacy
- In high demand

These characteristics make spatial enablement and SDI involvement challenging for land registries.

In summary the business of land registries can be summarized as producing “OPIT information”, meaning Owner, Parcel/Property, Interest and Transaction information generated by land tenure functions in land administration systems. This information concerns attributes to a parcel/property and relates to the space in the parcel, but it is not spatially enabled at registry levels. In most countries, including Australia, OPIT information is AAA land information.

So what is AAA land information? It is:

- Accurate – with on-ground truthing
- Authoritative – created within a regulated legal environment
- Assured – government guaranteed
- Importantly provides an authoritative audit trail for other land information data sets and services
- Add to AAA land information the power of spatial enablement and the vision of a spatially enabled society and government becomes a reality.
Today in Australia many players are not getting timely access to accurate data relating to tenure, value, planning, and development. Duplication is rife and citizen access in many cases is non-existent, partial and not spatially enabled. Many of the important restrictions that alter use of land or impose penalties for non-compliance with a legislated standard require diligent and frustrating enquiries. Simply AAA land information is underutilized both in its source state and territory governments and through the vertical tiers of governments, especially at a national level. It is an underutilized public asset.

3. Land and Property Information in 3D

People increasingly live in high density urban, often high rise and multi functional buildings. Cities require significant infrastructure above and below the ground in unique titles and arrangements. For instance, disputes arising from high density living in buildings with owners corporations increase as the public bring their expectations, while living in detached houses, into the village atmosphere of projects. Disputes among owners, owners and their corporations and owners and third parties, will increase in numbers and complexity. So will the efforts of institutions such as courts, administrative tribunals and informal dispute settlement centres, and bureaucracies to service them.

2D survey plans (even with stratum boundaries specified) are no longer able to represent the reality of these inter-related titles and land uses with their complex rights, restrictions and responsibilities (Figure 2). In addition, the 3D software applications in engineering, architecture and geographic information systems do not have the integrity demanded in land administration and property management where legal accuracy is axiomatic.

Figure 2: High rise building and its 2D representation in a land subdivision plan

Multiple page 2D plans cannot be easily understood or visualized outside the domain of the highly specialized professional cadastral surveyors. At the same time, 3D engineering architecture drawings do not deliver legal authority for rights, restrictions and responsibilities in land and property registration.
The lack of an efficient and effective three dimensional solution limits the ability of the public to visualize and communicate 3D developments, the ability of architects, engineers and developers to capitalize on the full potential of 3D title models; the ability of governments and developers to visualize multi-level developments resulting in increased costs and delays; and the ability of land registries to administer a title registration system that can accommodate these increasingly complex multi-level developments.

The importance and urgency of finding a solution for Australian cities has brought together research partners from the key government agencies, the national coordination bodies for these issues, experienced private sector professionals and companies in the development of multi-level developments, and a research team at Centre for SDIs and Land Administration, the University of Melbourne to provide a solution as a remedy to the dominance of the 2D approaches and the lack of proper technology and systems within the spatial industry globally.

This project aims to develop an innovative infrastructure which helps address the problem of modeling and managing complex 3-dimensional (3D) property rights, restrictions and responsibilities (RRR) in multi-level developments in our rapidly growing cities. This project will incorporate the third dimension of height into the property and land information systems (Cadastre) to build an infrastructure for managing and modeling spatial extension of these complex property RRRs. This research moves the multiple two dimensional drawings that now identify buildings and infrastructure objects and their separate parcels into authentic visual 3D images of the building and objects that meet the exacting legal standards of ground surveys. Property information systems based on 2D maps have served land administration and property management well for hundreds of years (Figure 3) based on the cadastral concept of an inventory of property parcels in two dimensions (FIG 1995).

However, most of the developed world (including Australia) and many developing countries now give ownership titles in buildings in three dimensions (3D) using the same 2D maps developed for traditional broad acre development on vacant land (Williamson 2002). It is the technical, legal and administrative problems surrounding the property rights, restrictions and responsibilities in the third dimension that are the focus of this project.
This project aims to deliver:

- An improved understanding of the problems and issues associated with incorporating 3D property information into land administration systems;
- A specification of the technical, policy, legal and institutional aspects of a 3D property information and representation system;
- A 3D data model and database management system;
- A 3D representation and registration model; and
- A prototype 3D property information and building representation system.
- A method to integrate 3D land and property information into 2D legacy systems
- A specification on policy, legal, institutional aspects of complicated management of

4. Conclusion

First the paper highlighted the significant impact of land administration systems (LAS) on spatial data quality and emphasize the importance of tenure, ownership, property boundary and street address data, created usually in land registries in government LAS, in the world of growing crowd sourced and VGI.
Spatial data created in LAS is defined as AAA land information that is Accurate, Assured and Authoritative. Importantly AAA land information has a documented and legally valid audit trail that is a key to good land governance and information management. The paper then introduces a continuum that starts with Volunteered Geographic Information (VGI) with lower quality and ends with AAA land information with the best possible quality. The continuum also highlights the advantages and disadvantages of VGI and AAA land information. The data in VGI is sourced from citizens’ participation and AAA land information is sourced from government LAS. In between, spatial data is created by the private sector, non-government agencies, local government and mapping agencies that have different levels of quality and integrity.

Second, the paper highlighted the need for 3D land and property information. The paper argued that people are increasingly live in high density urban, often high rise and multi functional buildings. These increasingly urbanized populations will predominantly live in multi-level, multipurpose, highly engineered, high-rise developments. Cities require significant infrastructure above and below the ground. Rapidly expanding vertical cities and their populations will experience a range of new environmental, social and economic challenges. The paper then introduced an approach which helps address the problem of modelling and managing complex 3D property rights, restrictions and responsibilities (RRR). The paper incorporates the third dimension of height into the land subdivision and development process to build an infrastructure for managing and modelling spatial extension of these complex property RRRs. This research moved the multiple two dimensional drawings that now identify buildings and infrastructure objects and their separate parcels into authentic visual 3D representation of the building and objects that meet the exacting legal standards of ground surveys.

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Abbas Rajabifard is a Professor and Head of Department of Infrastructure Engineering and Director of the Centre for SDIs and Land Administration at the University of Melbourne. He is President of the GSDI Association and a member of Victorian Spatial Council (VSC). He was Vice Chair, Spatially Enabled Government Working Group of the UN supported Permanent Committee on GIS Infrastructure for Asia and the Pacific (PCGIAP). He has been also consulted nationally and internationally on spatial data management, SDI, land administration and spatial enablement.
Address: Abbas Rajabifard, Department of Infrastructure Engineering, The University of Melbourne, Victoria 3010, Australia, abbas.r@unimelb.edu.au.

Mohsen Kalantari is a lecturer in Geomatics at the Department of Infrastructure Engineering and Associate Director at the CSDILA. Dr. Kalantari teaches Land Administration Systems (LAS) and his area of research involves the use of technologies in LAS and SDI. He has also worked as a technical manager at the Department of Sustainability and Environment (DSE), Victoria, Australia.
Address: Mohsen Kalantari, Department of Infrastructure Engineering, University of Melbourne Victoria 3010, Australia, saeidks@unimelb.edu.au

Ian Williamson is both a professional land surveyor and chartered engineer who is Professor of Surveying and Land Information at the Centre for Spatial Data Infrastructures and Land Administration, Department of Infrastructure Engineering, University of Melbourne, Australia. His expertise is the cadastre, land administration, and spatial data infrastructures.
Address: Ian Williamson, Department of Infrastructure Engineering, University of Melbourne Victoria 3010, Australia, ianpw@unimelb.edu.au
Spatially enabled land administration: paradigm shift in land information management


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