

**FIG  
SPECIAL**

GIM International Interviews

**Hernando  
De Soto**

**Beyond  
Cadastre 2014**

Let the Dialogue Begin

**Invited Reply**

*Towards Cadastre 2034:  
Part I and Part II*

# GIM

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The cover shows a Nepalese land surveyor using a graphical method of data capture in the terrain. Transfer of land in Nepal comes into effect once the owner has signed the notary deed. If the parcel is subdivided, the district survey office modifies the cadastral map using these methods.

## Let the dialogue begin!

It's with great pleasure that I present you with this special issue of *GIM International* on the occasion of the Working Week in Marrakech. This 'special' aims to provide a backdrop for shaping your thoughts around the cadastre of the future. In October 2010 we published a set of articles that proved real food for thought for professionals active in cadastres and land-registration systems. In July 2010 we published the feature 'Let the dialogue begin' by Rohan Bennett, Mohsen Kalantari and Abbas Rajabifard of the University of Melbourne, in which they presented six design elements relating to the role and nature of future cadastres, both as a starting point for further dialogue and as a reaction to the influential FIG publication *Cadastre 2014* produced by Commission 7 in between 1994 and 1998. In two subsequent issues of GIM, September and October 2010, senior editor Mathias Lemmens invited influential

thinkers and policymakers to reflect on this feature in the Invited Reply series 'Towards Cadastre 2034'. In October 2010 we carried an interview with Hernando de Soto, author of *The Mystery of Capital* and an advocate of land-registration systems aimed at decreasing poverty in the developing world. You'll find all these seminal articles here, reprinted in this collector's issue of *GIM International*. In the meanwhile, I wish you a great conference, full of fruitful discussions and, once again, let the dialogue begin!



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International Experts Speak Out

GIM INTERNATIONAL INTERVIEWS HERNANDO DE SOTO

# Cadastral with Couleur Locale



PHOTO COURTESY: MICHAEL O'NEILL STUDIOS

**A radical reappraisal of attitudes to the developing world is required of the geomatics profession. This is the view of Hernando De Soto, author of *The Mystery of Capital*, who in this interview offers GIM readers detailed insight into his concept of land registration for the poor. Land registration as means of escape from poverty is the major premise of De Soto, one of the foremost thinkers of our age on informal economy. Originally an economist, and president of the Peruvian Institute for Liberty and Democracy, he has shaped current thinking on land registration and its positive outcome for the poorest of the world. He shares his views at geospatial conferences all over the globe, and is presently working on two new books incorporating reflections on the world financial crisis, causes and outcomes, as well as ways to prevent a repeat performance. Publisher Durk Haarsma spoke to De Soto during a break from his hectic schedule, a peaceful writing retreat in Cornwall.**

**What has been the biggest change in your thinking since *The Mystery of Capital*?**

I still think that land registration is the starting point for people to escape the poverty trap. I am putting much more emphasis now on linkage to institutions that need to secure the value of titling. It's not just land recordation anymore, but also tying it to the whole system of a land or region. Awarding disproportionate credit to property created the bubble that when it burst produced the present recession. I therefore recognise a need for implementation of precise accountability for what is worth what. If you do not record adequately, the bits of paper get out of control. So we need rules or standards to keep track of the paper. That's something we need to organise at supranational level in the future. This goes for

both the developed and the developing world, especially the latter; recordation before we even start discussing regulation. Together with that we have to focus on adjusting systems to local conditions.

**What is the state of the art nowadays in the developing world?**

Good titling has been implemented in a few places over recent decades: Malaysia, South Korea and Japan are examples of places where systems have been put in place that work for the benefit of the citizen and their economic welfare. As a result these countries have moved into the 'highly developed' bracket. But bad titling continues in two thirds of the world. Bad titling means that a title is neither related to maps or registries nor backed by law and so plugged into the financial system. In my home country of Peru we have just discovered that the grounds of the presidential palace are owned by an indigenous tribe that lives 90 miles away from Lima. At least, there's a piece of paper that states so; but the bit of paper isn't linked to any system whatsoever. What does this mean in terms of backing up the title? This sort of standalone titling is not sustainable over time.

Hernando De Soto



**Hernando De Soto** (Arequipa, Peru, 1941) is an economist and president of the Institute for Liberty and Democracy (ILD) in Lima, Peru. In 2000 De Soto published *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else*,

in which he advocates land registration as a solution to the problem of world poverty; land registration and granting property rights make possible bank loans and thus access to the formal economy. De Soto has, among other posts, been advisor to former Peruvian president Fujimori, and he serves with ex-US Secretary of State Madeleine Albright on the Commission on Legal Empowerment of the Poor (CLEP) of the United Nations Development Program. ILD is carrying out capital-raising projects for the poor in more than thirty countries.

**Does the Western world, where almost everything is recorded, provide an example for the developing world?**

There's no simple answer to that. It is one of the major strengths of the Western world that everything is recorded, which naturally instils trust

## *Land registration is the starting point for people to get out of the poverty trap*

in the existence of properties so documented. It makes easy the creation of wealth. In the developing world the majority of property isn't recorded, leading to territorial conflicts like that in Darfur, but it also results in a large population of poor people with no access to the formal economy. So again, everything starts with recordation. We have to start from there and take things on to the next level.

**What will the cadastre of the future look like?**

Because titling is often not linked to financial institutions or backed by the law, that is what we need to work towards. We have to realise that recording isn't just about registering, but about linking. Titling needs to be interactive and interchangeable. People in the developing world are migrating at a pace previously unknown. We need to make sure that when there is a change in ownership of a property we are able to register the new owner; there needs to be a firm base for registration. And, most important, this needs to incorporate local and regional habits and traditions, together with the existing social contract. Almost like a cadastre with 'couleur locale'.

**What does this require from surveyors in the developed world?**

The notion that simply laying the template used in the developed world on the developing world won't work. As soon as a Mexican crosses the border into Arizona he wants to be



listed in the telephone book, whereas back in his home country he would have found such a thing absurd. In order to resolve poverty we need to change the culture in such a way that everyone wants to be in listings like phonebooks and cadastres to ensure a way out of miserable living conditions. Here we are so used to the fact that property is registered that we never give it a second thought; in other parts of the world the reverse is true. This difference in culture can only change gradually and from the angle of the developing world. It's also important that we rid ourselves of the idea that other people are disinterested in being registered in a system. They know, looking at the Western world, that registration means entrance to the world of capital, but at the same time they want to preserve their own identity,

their cultural background and roots. Step one for us is to understand this and start at the right level. Step two comes next.

***You've mentioned how fast people are moving about; rapid urbanisation, favelas or townships, there is great volatility in settlement. How to deal with this?***

We have to take into account this kind of migration. Not look at the situation and sit and think 'these South Africans are so different from the Dutch, they don't stay put in the same place', but rather acknowledge that South Africans are just like the Dutch, only sometimes just don't know where they should stay put. Factored into an indigenous land-registration system must be the fact that in 25 years' time 90% of the population won't be living in the same place. Make sure that land is recorded and ownership of a property can change.

***Who will be the most important parties in structuring this land registration of the future?***

Politics is of course the prime driver for implementing new and successful land-registration systems in the developing world. Demand for maps always comes from the authorities. We at the Institute of Liberty and Democracy consider governments our

incorporate in the software differences in tradition, culture and history. Software that works in Amsterdam won't necessarily work in Jakarta. If software used in the developing world could anticipate the process from local symbols and historical geographical references to the standardised and globally accepted methods of geographical reference, it would be a major step. This is something we realised about year ago: using land-registration software with a local component is key! And of course, making it local means more than just translating it into the indigenous language. All developing countries will achieve a land recording system over the next eighty years - but why don't we do it in twenty?

***Are manufacturers already thinking about incorporating this local component?***

A few years back, I would have said 'no'. At the same time I would have thought, what do 'mapmakers' know about bringing non-graphical information into software. But software has become much more flexible. Since last year we have been talking to a few companies about the realities of putting non-graphical information to work in mapping software. It's an amazing and challenging discussion. But

## *Software that works in Amsterdam doesn't necessarily work in Jakarta*

natural partner, and we have been called upon in more than thirty countries to look at the possibilities for setting up a land-registration or titling system. But our mission is purely intellectual. To put the fruit of these discussions into practice we need the geomatics industry as booster.

***What does the geomatics industry need to do to make possible optimum cadastre for the developing world?***

The biggest challenge for manufacturers is to bring into the system, or

implementation of these 'smart' land-registration systems will be vital for the future of the geomatics business and to the aim of reducing poverty over huge areas of the developing world. ◀

**MORE INFORMATION**   
<http://ild.org.pe>

LET THE DIALOGUE BEGIN

# Beyond Cadastral 2014

**Multipurpose cadastral, Cadastral 2014, and sustainable land administration have radically altered understanding of cadastral and their potential over the last thirty years. Many of these concepts continue to be relevant. However, the world is not in stasis, so cadastral science must anticipate and facilitate emerging change. The authors present six design elements relating to the role and nature of future cadastral as a starting point for further dialogue.**

Globalised society will affect the design of future cadastral. Firstly, will be a need for survey-accurate cadastral data; secondly, a shift in focus from land parcels to property objects. Third will be a need for height and time information, and fourth for real-time updating and accessing cadastral databases. Then there are complex commodities in the land market traded worldwide that induce the need for regional and global cadastral networks, and a requirement to model the organic natural environment. These factors will be elaborated here, including progress status and what needs to be done.

## SURVEY ACCURACY

Digitising cadastral paper maps, carried out in the 1980s and 1990s, significantly diminished accuracy. Whilst earlier paper-based cadastral plans exhibited survey accuracy (sub-centimetre), this is not so for many modern digital cadastral databases; crude digitisation of paper maps introduced large errors (Figure 1). Many applications will require survey accuracy, including building management, utility administration, infrastructure organisation, precision farming, navigation and sea-level rise response. Not only will survey accuracy be needed for ownership parcels, but also the hundreds of new and emerging property objects, so as to accurately understand the complex layering of property interests. Countries and states equipped with survey-accurate cadastral are far better placed to manage these challenges. A good amount of literature describes the concept of survey-accurate cadastral. However, the majority has been based on experience from New Zealand, Malaysia, Israel and Australia. An audit of other jurisdic-

tions appears necessary. The desire for survey accuracy has recently been informally described as a preoccupation of uncertainty-averse surveyors: fitness for purpose would be a better goal. Whilst this might be true, a survey-accurate cadastral will presumably fit all purposes and therefore remain an ongoing aspiration, particularly as costs fall ▶



**Rohan Bennett** and **Mohsen Kalantari** both gained their doctorate in 2008 and work as research fellows at the Centre for Spatial Data Infrastructures and Land Administration, The University of Melbourne, directed by Ass. Prof. **Abbas Rajabifard**; the latter is current president of the GSDI Association.

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◀ Figure 1, Cadastres will move from approximate boundary representation (left) towards survey-accurate boundary representation.



◀ Figure 2, Cadastres will change from purely parcel-based systems (left) towards systems of layered property objects.



◀ Figure 3, Cadastres will expand from 2D approaches (left) to include 3D (right) and 4D perspectives.

and expertise required for implementation becomes less.

#### PROPERTY OBJECTS

The proliferation of new property rights, restrictions and responsibilities will force a shift in focus from land parcels to property objects. Parcels will continue to be an important people-land organisation tool. However, many new interests exhibit vastly different spatial footprints (Figure 2). Much theoret-

ical work has been undertaken, such as the Land Administration Domain Model using the UML object-oriented language. Practical implementation will require smart investment and re-engineering of cadastral systems and processes.

#### HEIGHT AND TIME

Management of vertical villages, proliferation in property interests, and sustainability analysis require modelling and visualisation of

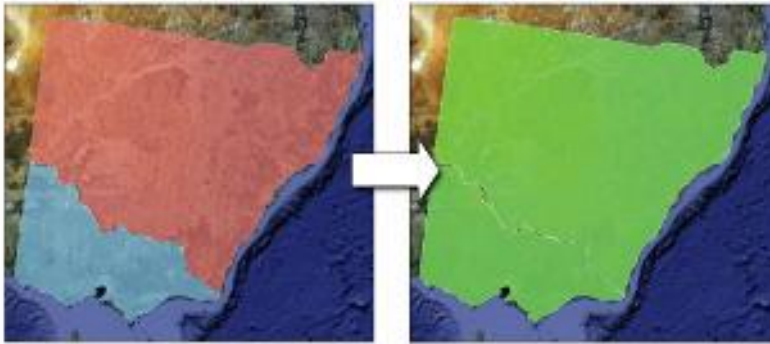
the third (height) and fourth (time) dimensions (Figure 3). Availability of the third and fourth dimensions will greatly reduce administrative friction caused by misinformation and poor understanding of property interests, and thus planning and development times. Preliminary work undertaken to understand legal and other barriers, coupled with ongoing technical advancements, will enable the extension of traditional 2D cadastres to 3D and 4D.

#### REAL-TIME

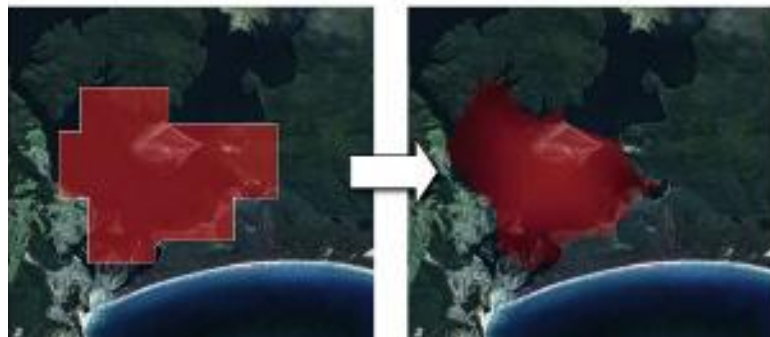
Emergency management, property-market management, fiscal policy, and navigation tools require cadastral information to be updated and accessed in real time. Updating may currently take weeks or months in most jurisdictions. To date, mobile computers and GPS units enable utility companies to achieve real-time updates across their networks. This technology will also enable cadastral surveyors to measure and instantaneously update while in the field. Robust checking processes will continue to ensure integrity. Although there exists minimal literature on real-time cadastres, research on marine-management systems may provide initial clues, since these aim at modelling extremely dynamic environments.

#### REGIONAL AND GLOBAL

Globalisation clearly affected mortgage-backed certificates and other complex commodities in the land market. For example, a lack of accurate and timely information led to international investors purchasing toxic US property commodities as information on the mortgage practices in the US became available too late. Interoperable cadastral systems would appear to offer a method for integrating and better understanding the relationship between land markets (Figure 4). In these, as with international share trading, high-integrity information will be essential for organising investments. Regional links between



◀ *Figure 4, Disparate national and state-based cadastral systems, indicated red and blue (left), will become interoperable at regional and global levels.*



◀ *Figure 5, Property interests are now designed around strict bearings and distances or Cartesian coordinates (left) but future cadastral systems will better model the organic natural environment by enabling fuzzy and dynamic boundary definitions.*

states, countries and other jurisdictions are already emerging. An example is PSMA Australia's 'Cadlite', which provides an aggregated model of Australia's inherently state-based cadastral systems. Moreover, technical standardisation such as the Land Administration Domain Model, legal property object model, and Australia's ePlan initiatives will enable easier interoperability between systems. Problems and concerns about the environment are often spread over multiple jurisdictions, so environmental management also requires integration of cadastral systems at regional and global levels. The Murray-Darling Basin in Australia provides an example. The European Union is working on standardising the cadastral domain to enable integration in the medium term. The Asia-Pacific region, through the Permanent Committee on GIS Infrastructure for the Asia-Pacific (PCGIAP), has also conducted preliminary work on linking regional and global cadastral networks.

#### FUZZY AND ORGANIC

Many new property interests are designed around natural phenomena rather than the strict bearings and distances or Cartesian coordinates found in traditional land parcels (Figure 5). For example, many interests in the marine environments exhibit fuzzy and changeable boundaries. Legal controls protecting flora and fauna or the land interests of

## *Shift in focus from land parcels to property objects and need for interoperable cadastral systems*

indigenous communities, such as those found in developing countries, are often vague and require new tools for representation and management. The continuous movement of such boundaries can be measured and

visualised within the cadastral framework using Ambient Spatial Intelligence achieved through Wireless Sensor Networks.

#### MUCH STILL TO DO

While much theoretical work has got underway on some elements, work is still needed on all. Collaborative research, most likely through the FIG Commission 7 framework, would enable further development of design concepts and assist in defining the nature and role of future cadastral systems.

#### ACKNOWLEDGEMENTS

Thanks are due to Christiaan Lemmen, Ian Williamson and Jude Wallace. This paper is modified from Bennett, R., Kalantari, M., Rajabifard, A., Wallace, J., Williamson, I., (2010), *Cadastral Futures: Building a New Vision for the Nature and Role of the Cadastre*, Proceedings of the XXIV International FIG Congress, 11<sup>th</sup> - 16<sup>th</sup> April, Sydney, Australia. ◀

#### FURTHER READING

- Bennett, R., Kitchingman, A., Leach, J., (2009), On the Utility and Nature of Natural Boundaries for Land and Marine Administration, *Journal of Land Use Policy*, vol. 27, no. 3, pp772-779.
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- Lemmen, C., and Oosterom, P., (2003), 3D Cadastres; *Computers, Environment and Urban Systems*, vol. 27, no. 4, July 2003, pp337-343.





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INTERNATIONAL EXPERTS SPEAK OUT

# Towards Cadaastre 2034

**To what degree have the objectives of *Cadaastre 2014* been accomplished? What are the societal and technological dynamics that may affect the international practice of land administration over the coming twenty years? Bennett and co-authors from the University of Melbourne, Australia, have described six design elements relating to the role and nature of future cadastrals, presented at the FIG 2010 congress in Sydney and published in *GIM International* (July 2010); an inspiring starting point for further dialogue. To encourage discussion we invited leading experts and practitioners to send us their own views and vision. We received no fewer than ten replies; five are printed here, five will be published as Part II in the October issue of *GIM International*.**

*Cadaastre 2014* is an influential publication produced by a FIG Commission 7 working group between 1994 and 1998. The task was to develop a vision for the modern cadastre of twenty years hence. Authored by working-group chairperson Jürg Kaufmann and secretary, Daniel Steudler, both also contrib-

uting to this Invited Reply, this excellent review of the strengths and weaknesses of cadastral systems of twenty years ago and vision for the future, were presented at the FIG Congress in Brighton in July 1998. As Prof. Ian Williamson, then chair of FIG Comm. 7, noted in his foreword, the vision recognised many ongoing changes, including the role of government and surveyors in society, relationship of humankind to land, the growing role of the private sector in cadastre operation, and dramatic influence of technology on cadastral reform.



**Mathias Lemmens** holds an Ir (MSc) degree in Geodesy and received his doctorate from Delft University of Technology, Netherlands, where he presently holds a post as assistant professor. He operates as an international consultant focused on emerging and developing countries. He was for ten years

editor-in-chief of *GIM International* and now contributes as senior editor.

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## MAGIC NUMBER

As we rapidly approach the year 2014 it becomes relevant to ask to what degree the objectives of *Cadaastre 2014* have been accomplished. Those involved in land administration also need to signal societal and technological dynamics that may affect the practice of land administration worldwide over the coming twenty years. Rohan Bennett, Mohsen Kalantari and Abbas Rajabifard, all scientists at the University of Melbourne, Australia, took the laudable initiative of isolating six design elements:

- move from approximate boundary representation towards survey-accurate boundary representation
- focus shift from purely parcel-based systems towards systems of layered property objects
- expansion from 2D approaches to include the third (height) and fourth (time) dimensions
- updating and accessing of cadastral information in real time
- making national and state-based cadastrals interoperable at regional and global levels
- inclusion in property interests, ▶

now designed around strict bearings and distances or Cartesian coordinates, of modelled organic natural environment by enabling fuzzy and dynamic boundary definitions.

Six seems to be the magic number when it comes to developing a vision on the future of cadastres. The authors of *Cadastre 2014* too presented six topics, calling them not 'design

elements' but 'statements'. For the sake of completeness we present these, distributed throughout this article and accompanied by illustrations from the original publications.

## Technology: Enabler not Driver



**Keith Clifford Bell** joined the World Bank in 2003 after a career in the Australian public and private sectors conducted alongside a parallel career as an Army reserve. He leads the World Bank land programme across the East Asia region, and advises others.

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Delighted to be invited, although responding presents me with quite a dilemma! It is highly commendable to 'let the dialogue begin', but Dr. Bennett et al. have adopted a supply-driven, techno-centric approach: spatial accuracy, new geospatial technologies, and so forth. Their emphasis is on the spatial component rather than on broader and more important social, legal, fiscal, economic and environmental issues. For sure, a robust and healthy debate will ensue!

### CADASTRE 2014

No other document on cadastral reform has been so widely accessed, quoted and misquoted, dissected and repackaged, as well as applauded criticised, utilised and plagiarised as the seminal *Cadastre 2014*. Its strength has been its success in raising awareness and encouraging debate. It has fostered broader multidisciplinary and cross-sectional dialogue. It was published before De Soto's *The Mystery of Capital* and the accompanying plethora of accolades and rebuttals, and before the Millennium Development Goals (MDG) were in place. Climate change and food security were not yet on the global radar screen. It was clearly influenced by John McLaughlin's multi-purpose cadastre, around since 1975. *Cadastre*

► *Figure 1, Gender equity: the World Bank facilitates women in developing countries to access land rights. (Top to bottom):*  
 - woman completing adjudication forms in Bireuen (Indonesia);  
 - woman registering claim on ownership of land (Rwanda, 2008);  
 - woman lugging land markers;  
 - mother getting her title (Indonesia).



*2014* does not explicitly refer to land governance as an issue, but raises throughout many governance themes; it is therefore particularly significant that FIG, the World Bank and United Nations institutions are now placing such strong emphasis on land governance, especially in the light of a global land-grab rush.

### DEMAND-DRIVEN FOCUS

It is time for the demand-side view, prioritising important social, legal and environmental agendas: securing basic rights; providing for equity, fairness, transparency, accountability and the rule of law (Figure 1); government decentralisation; and responsible triple bottom-line sustainable development. The cadastre is fundamental to responsible, sustainable development of land, the most fundamental natural resource. Hence the importance of registering all land parcels, both state and private, with an appropriate level of spatial accuracy. However, not every right and interest in land requires registration. This is especially true for countries where people live in extreme poverty, defined as existing on less than USD1.25 per day, and governments and donors need to make hard strategic choices in allocating limited funds.

### LAND GOVERNANCE

All too often, across all regions, the powerful elite grab land and enrich themselves by encouraging international and local investors in agribusiness, mining, forestry and infrastructure to the detriment of the poor and the environment. The high level of corruption prevalent in the land sector in many countries, especially under the 'Global Land Rush', is a major concern. The harmful effects are obstruction and manipulation of cadastral information, resulting in discrepancies between

reality and registration that foster abuse on the part of the powerful. The bottom line is that information stored in cadastral registers should be trustworthy, but such good governance is obstructed by social power structures. Only recently have these topics become subjects of open discussion. Technology should be about improving transparency, good governance and peoples' access to services.

**PRIORITIES**

What is important is completeness of the land inventory and good land

governance. Are real-time, spatially accurate cadastres more important than water, sanitation and nutrition? Other than for national borders and maritime boundaries, I don't see arguments for investment in interoperability of systems across international borders, the exception being within the European Union. Australia's efforts to bring about e-conveyancing over its eastern states have been plagued with problems and controversy. My work across three regions has shown me cadastres over-engineered,

often by vested interests, in pursuit of high spatial accuracy, with little attention for the real need to build and maintain sustainable cadastral systems. Considerations concerning spatial accuracy should always be based on fitness for purpose! Improvements in spatial accuracy and records should be demand-driven and achieved incrementally over time. Technology should be enabler not driver. Investments must be sustainable and relevant to the needs of broader society, not about strengthening technocratic geospatial silos.

**Continuum of Rights**

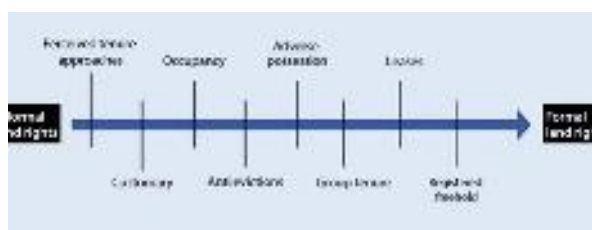


**Dr. Mohamed El-Sioui**, head of Shelter Branch, UN-HABITAT, has over 30 years international experience practicing, advising, training and teaching in the human settlements field.

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Bennett and co-authors project the future shape of cadastres. These systems will transform cadastres from two-dimensional parcels to property objects capturing their three dimensions and metamorphosis over time. These new levels of sophistication will add particular value to properties of historic, architectural or high value. Given the current time involved in developing cadastres, such enhancements will involve even more time and cost, even if technology gets cheaper. In the case of important properties this is certainly justified. We at UN-HABITAT look at the other end of the property spectrum. We are concerned with rights of access to land,

▼ Figure 2, Land rights range from informal to formal.



▲ Cadastres may not exist for ever; following destruction of land offices by the Aceh Tsunami (left) tremendous efforts were needed to re-establish titles. (Courtesy: World Bank.)



particularly by the poor. In most developing countries only a very small proportion of properties are captured in cadastres; maybe as little as 15% in some countries. In African developing countries less than 30% of land is in cadastre systems, and only 2% of women own land; rights of access to the remainder are governed by various systems, including customary, tribal and others, mostly not officially recognised. That is, they are not documented.

**STDM**

To address these types of rights and bring them into the spectrum of documented property there is a need to acknowledge a continuum of rights that starts in the lower range, including perceived, customary, occupancy and group tenure, and extends to the more legally binding leases and registered freehold (Figure 2). To address this gap, partners in the Global Land Tool Network (GLTN) including the International Federation of Surveyors (FIG), the Faculty of Geo-information

and Earth Observation (ITC) at the University of Twente, the World Bank and the United Nations Human Settlements Programme (UN-HABITAT) have jointly developed a new tool: the Social Tenure Domain Model (STDM). This was launched during the 24<sup>th</sup> (FIG) Congress held from 11<sup>th</sup> to 16<sup>th</sup> April 2010 in Sydney, Australia, and has the capacity to integrate informal, formal and customary land information, contributing to improved tenure security for the poor and vulnerable groups like women. The challenge now is to link these two land-information systems: the highly sophisticated multi-dimensional *Beyond Cadastre 2014* and the rights-based STDM. The systems are complementary, addressing as they do the needs of diverse clients representing often differing but intertwined juridical and social realms. UN-HABITAT would like to see further discussion and research focused on linking the two systems to support the growth and development of cities without leaving behind the poor. ▶

## FIG Should Take Lead



**Jürg Kaufmann**, graduate of the Federal Institute of Technology in Zürich, has since 1988 been an independent national and international consultant engineer based in Switzerland. With a background in surveying and business administration, he became a Swiss Federal Licensed Surveyor in 1981. He is co-author of the

FIG Publication *Cadastré 2014* and was awarded FIG honorary membership in 2006. From 2003 to 2010 he was president of the Swiss Association of Geomatics and Land Management, of which he is also an honorary member.

As an author of *Cadastré 2014*, I am pleased that the cadastral aspects are dealt with in a comprehensive manner. This was our aim when we recommended that FIG 'promote and sponsor a competence centre for modern cadastral systems'. The authors address a range of aspects to be taken into consideration when thinking about the future of cadastral systems, and they do this with an overall view which is highly appreciated.

### BOUNDARIES: THE REAL CHALLENGE

For too long now, discussions have centred only on individual aspects addressed in an isolated and parcel-focused manner. Neglected has been the fact that the institution of 'Cadastré' has to adapt to new legal arrangements necessarily introduced to organise habitats within an

increasingly complex and populated environment. The organisation of habitats requires determination and documentation of boundaries. This technique is applied by nature in many societies, and even by animals. All boundaries defined by modern legislation creating property or, in the sense of *Cadastré 2014*, legal land objects, are the real topic of and challenge to modern cadastral systems. So I would give first priority to statements about boundaries and overcoming restrictions on parcels. However, I agree in general with the remarks on survey accuracy. The need for accuracy is defined by scarce resources and dense population. In

the procedures. The term 'uncertainty averse' might be appropriate here.

### COMMON UNDERSTANDING

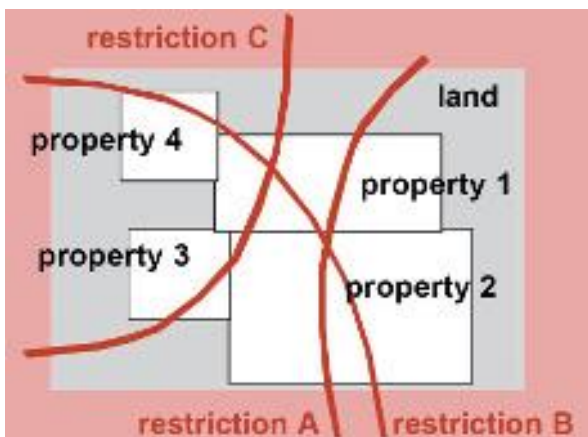
Regionally and globally linked cadastres will emerge with the application of ICT tools. The main factor in success will be common understanding of the contents of cadastral systems. The *Cadastré 2014* definition with legally independent information layers and correct data models is vital to achieving mutual understanding. The statement on a fuzzy and organic approach brings us back to the key issue of cadastral systems: boundaries. Answers to the question of precise boundary

## Need for accuracy defined by scarce resources and dense population

view of trends in cost and expertise, we may expect the accuracy issue to figure less large in the future. The moment we accept the dominant role played by legal objects in modern cadastré, the 3D and 4D problems will be solved. It is possible to use 3D coordinates to locate these objects. The fourth dimension is resolved as soon as legal procedures are integrated into the system. Real-time maintenance and access is mainly a matter of mental change. We dispose of the technical tools, but surveyors (and lawyers) hesitate to re-engineer

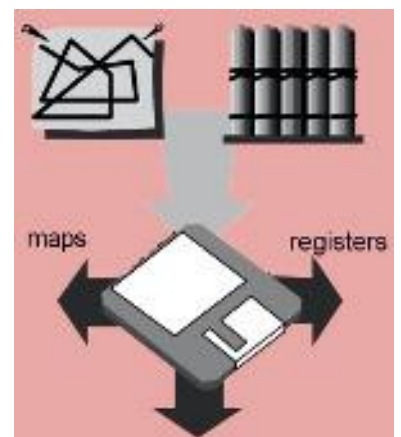
localisation can be found only within the legal frameworks and respective case law. Society must define how to deal with this aspect; research is needed to determine how it reacts to fuzzy boundaries. It seems a breakthrough in this field would accelerate urgently needed mental change.

In my view *Cadastré 2014* still provides a valuable framework. It is time for FIG, together with research institutes, to take the lead in developing comprehensive modern cadastral systems. ▶



◀ *Cadastré 2014* will show the complete legal situation of land, including public rights and restrictions!

▶ *The separation between 'maps' and 'registers' will be abolished!*



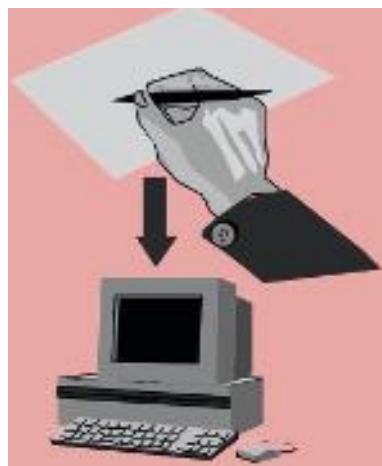
## Finnish Perspective



**Jarmo Ratia**, since 1991 director general and CEO, National Land Survey of Finland, has held many administrative positions in national and international organisations including the 1996-1998 presidency of CERC (Comité Européen des Responsables de la Cartographie Officielle). He was GSDI president from 2006-2008, and president of the Permanent Committee on the Cadastre in the European Union in 2006.

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Bennett, Kalantari and Rajabifard have made a very interesting contribution to discussions concerning the role of cadastre in modern society. Some of their main ideas are discussed below from a Finnish point of view. According to Finnish legislation and century-long practice, a boundary is defined first and foremost according to markers in the ground. Only in cities, for practical reasons, do coordinates play a decisive role. In large rural areas only some boundary beacons have accurately surveyed coordinates. For areas involved in development plans, more thorough coordinate information can be produced by improving the cadastral index map. Establishing survey coordinates for the whole country is, however, not considered



◀ *'Paper-and-pencil' cadastre will have gone!*

▶ *Cadastral mapping will be dead! Long live modelling!*

economically sensible now or in the near future. Introduction of a coordinate-based cadastre in Finland would be a leap into the unknown. Striving for a survey-accurate cadastre is desirable as such, but its practical realisation requires the simultaneous development of legislation, IT systems and work processes. In any case, a long transition period would be needed. From the information service point of view, creating a metadata repository concerning the cadastre would in the first instance serve changing customer needs.

### CROSSING BORDERS

The new dimensions of the cadastre (time and height) are closely connected with a change in focus

Finland, but for the time being there is no urgent need for cadastral registration of every such right. It is, however, a logical future developmental step. Interoperability of national cadastral systems on the one hand, and the cadastres and other registers within them on the other, is an important goal. This has also been stated in the EuroGeographics vision on cadastre and land registration. There are several ongoing European and global projects the aim of which is either to lay foundations for or build systems that enable cross-border information flow. Among these are LADM, as well as EULIS, the INSPIRE directive, and national SDIs and eJustice. The National Land Survey of Finland is convinced

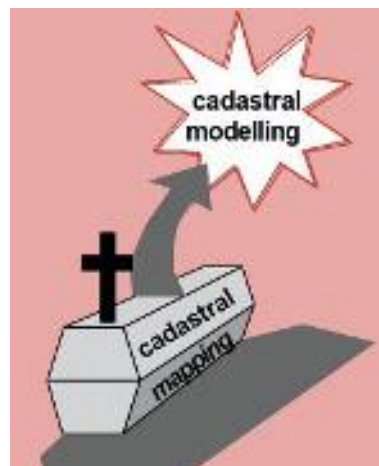
## *Need for 3D-properties undisputed, especially in city centres*

from parcels to property-object or property-right approach. The need for 3D-properties is undisputed, especially in city centres. So in Finland preparatory work is underway towards enabling 3D-property formation. The need for registering the time aspect lies even farther in the future. The most obvious example of this type of phenomena is the 'time share', which is quite common in

that use of a cross-border cadastral information service will multiply over the coming decade or so. So that common efforts should be particularly directed towards building efficient information services.

### NATURAL BOUNDARIES

A natural conservation area is an example of a restriction that does not follow parcel boundaries. In Finland prerequisites and process have been defined for forming a cadastral unit with fixed boundaries of, for example, such a conservation area. Natural phenomena such as post-glacial rebound or riverbank migration may again mean a cadastral boundary no longer runs along the original shoreline. These sorts of discrepancy can be dealt with in cadastral surveys and in the cadastre. Little or no importance has been paid to the idea of letting a boundary follow a moving geographical feature. ▶



## First Thoughts



**Dimitris Rokos** holds a degree in Rural and Surveying Engineering from the National Technical University of Athens, and received a PhD in Geography from the University of Iowa in 1995. Since 1996 he has been involved in the Greek Cadastre. He currently holds the position of deputy director of projects with Ktimatologio S.A., the state company responsible for developing Cadastre in Greece.

As 2014 fast approaches, the cadastral community needs to ponder to what extent the goals of *Cadastre 2014* have been achieved and try to identify new trends and user needs beyond 2014. The discussion is now open, and what follows are some first thoughts on the six design elements presented. Real property objects emerge as a natural evolution of *Cadastre 2014*'s third statement concerning cadastral modelling. Real property objects are, however, generally three-dimensional (especially in the context of urban environments) and may have fuzzy boundaries (indigenous rights, ecosystems, marine environments). To better integrate such real property objects in our cadastral systems, not only their visual representations but also their spatial and legal interactions must be effectively modelled. These complex interactions stop the issue of real property object representation being limited to just footprints

and recording a height. New ways have to be adopted to allow 3D representations in the daily operation of cadastral systems. This will probably require the integration of digital representations of real property objects in titles and deeds which, to realise their full potential, must as future standard become digital documents (digitally signed).

### ACCURACY AND TIME

The issue of survey accuracy should be addressed with care, as this will considerably affect the cost of upgrading and maintenance. A

Time as a fourth dimension introduces the concept of recording history of real property objects and changes in rights, restrictions and uses on them. Tools for analysing and visualising change through time must be formalised, as the fourth dimension will allow better study of real property market trends and provide a very important tool for planning and development.

### PROPERTY MARKETS

Globalised economy is now a fact, and such an environment confronts cadastre with new challenges.

## Better realise potential of global and regional real-property markets

cost-benefit analysis should precede such a decision, evaluating the benefits projected to arise from its extended usage. This, however, does not contradict a systematic effort to gradually upgrade the quality of the information contained in a cadastral database by incorporating newer and more accurate measurements conducted in the context of everyday operation (i.e. subdivisions, adjudication of cadastral boundaries). This can be achieved by documenting with appropriate metadata the level of quality/accuracy of each cadastral element, thus defining its possible future uses.

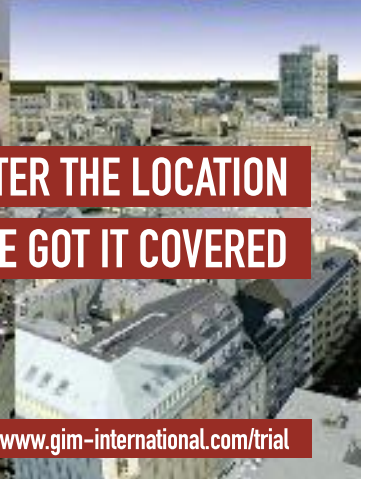
Although cadastres around the world carry different historical, political and cultural characteristics which make each system if not unique, at least different, there is now a stronger need to better realise the potential of global and regional real property markets. Projects like the European INSPIRE Directive, the Land Administration Domain Model and EULIS offer various approaches to the goal of interoperability. It remains to be seen whether the 'stricter' and more formal modelling of LADM or the 'looser' EULIS common portal will be the approach that eventually manages to achieve a 'usable' globalised cadastral picture.

## Concluding remarks

In Part I of the Invited Reply on 'Beyond Cadastre 2014' the following international experts put forward their views and opinions: Keith Clifford Bell, World Bank; Dr. Mohamed El-Sioufi, UN-HABITAT; Jürg Kaufmann, co-author of *Cadastre 2014*; Jarmo Ratia, National Land Survey of Finland; and Dimitris Rokos, Ktimatologio S.A., Greece. In Part II, to be published in GIM's October issue, another five international experts will speak out: Dr.

Clarissa Augustinus, UN-HABITAT; Dorine Burmanje and Dr. Martin Salzmann, Kadaster, Netherlands; Paul van der Molen, Twente University (ITC), Netherlands; Daniel Roberge, Quebec cadastre, Canada; and Daniel Steudler, co-author of *Cadastre 2014*. What conclusions can be made from the replies given by the experts to the six design elements proposed? This question will be answered in Part II. Many thanks to all the professionals mentioned above for their contribution to this discussion. ◀

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INTERNATIONAL EXPERTS SPEAK OUT

# Towards Cadastral 2034: Part II

**Bennett and co-authors from the University of Melbourne, Australia, have described six design elements relating to the role and nature of future cadastral systems, presented at the FIG 2010 congress in Sydney and published in *GIM International* (July 2010); an inspiring starting point for further dialogue. To encourage discussion we invited leading experts and practitioners to send us their own views and future vision. We received no fewer than ten replies, half of which were printed in the September issue. Here are the remaining five.**



**Mathias Lemmens** holds an Ir (MSc) degree in Geodesy and received his doctorate from Delft University of Technology, Netherlands, where he presently holds a post as assistant professor. He operates as an international consultant focused on emerging and developing countries. He

was for ten years editor-in-chief of *GIM International* and now contributes as senior editor

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*Cadastral 2014* is an influential publication produced by a FIG Commission 7 working group between 1994 and 1998. Approaching 2014 it becomes relevant to ask to what degree the objectives of *Cadastral 2014* have been accomplished and what are the societal and technological dynamics that may affect the practice of land administration worldwide over the coming twenty years. Rohan Bennett, Mohsen Kalantari and Abbas Rajabifard, all scientists at the University of Melbourne, Australia, took the initiative of isolating six design elements for future cadastral systems (see side bar). In Part I of the Invited Reply on *Beyond Cadastral 2014* the following international experts voiced their views and opinions: Keith Clifford Bell, World Bank; Dr Mohamed El-Sioufi, UN-HABITAT; Jürg Kaufmann, co-author of *Cadastral 2014*; Jarmo Ratia, National Land Survey of Finland; and Dimitris Rokos, Ktimatologio S.A., Greece. One of the five respondents in Part II, Daniel Steudler himself co-authored *Cadastral 2014*. We start with his reply. In Part I,

four of the six statements of *Cadastral 2014* were presented together with the illustrations from the original publication. For the sake of completeness, we present the remaining two statements in this Part II.

- Move from approximate boundary representation towards survey-accurate boundary representation
- Shift focus from purely parcel-based systems towards systems of layered property objects
- Expansion from 2D approaches to include the third (height) and fourth (time) dimensions
- Updating and accessing of cadastral information in real time
- Making national and state-based cadastral interoperable at regional and global level
- Inclusion in property interests, now designed around strict bearings and distances or Cartesian coordinates, of modelled organic natural environment by enabling fuzzy and dynamic boundary definitions.

## Strategic Significance



**Daniel Stuedler** has worked for the Swiss Federal Directorate for Cadastral Surveying since 1991. He has conducted extensive research in the field of cadastral systems and co-authored *Cadastre 2014*. Since 2003 he has been the Swiss delegate to FIG Commission 7 and is currently its vice-chair.

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Congratulations and thanks the University of Melbourne team for reviving the dialogue on cadastral science and developments! Some issues raised, such as survey accuracy, object-orientation or information layering, were already dealt with in principle in the original *Cadastre 2014* publication, but experience has shown that they need more and continued emphasis and discussion. Often mistaken for purely technical issues, they are of great strategic significance, with serious implications for the conceptual design of a cadastre. The benefits, however, are substantial, as the article by Bennett and co-authors clearly illustrates. Other issues, such as '3D and 4D', 'real-time processing',

'regional and global scales', and 'fuzzy and organic', are contemporary topics and certainly need to be discussed.

### DATA MODELLING AND RRR

Two issues from the original *Cadastre 2014* need to be emphasised: data modelling, and extension of cadastres with RRR (rights-restrictions-responsibilities). Cadastral systems are documentation systems: data collections of authentic official data stored in digital databases. A clear definition of the final product is needed, to be made using data modelling techniques, if possible in a system-independent way in order to guarantee broad data interoperability.

Examples that would have to be considered in future discussions include water rights or carbon credits, ever higher on government agendas. Global warming is increasingly facing societies with natural disasters. This situation requires enhanced preparedness through better disaster management; that is, better prior data. Data about protection and hazard zones, as well as landownership information, play an important role.

### CHANGE IN PARADIGM

It is crucial for the profession to understand that cadastral systems, like topographic mapping, are in the midst of a change in paradigm. The digital revolution requires ubiquitous access to data and information in digital form. Drawing maps is not the first priority, but provision of information to be stored in readily accessible databases. The issues around cadastral systems are more complex than they seem, but it is a motivating challenge to explain their potential to society and decision-makers. Let's continue the dialogue; FIG Commission 7 over its coming four-year term 2011-14 will certainly continue its commitment to collaborative research in this field.

## *Drawing maps not the highest priority, but provision of information*

The documentation of RRR and their integration into the cadastre has already begun in some, mainly developed, countries to better manage scarce-resource land and make the land market more transparent.

## Accuracy No Solution



**Dr. Clarissa Augustinus**, chief of the Land, Tenure and Property Administration Section, Shelter Branch, Global Division, UN-HABITAT, received a PhD in Social Anthropology based on her research into customary and informal land tenure in an informal settlement in Africa.

Prior to joining UN-HABITAT she was senior lecturer at the School of Civil Engineering, Surveying and Construction, University of KwaZulu-Natal, South Africa, focusing on land management. She has also acted as an international consultant on land management and administration from an institutional perspective.

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There exists enormous global challenges for which the land industry needs to produce solutions. The current accurate parcel-based *Beyond Cadastre 2014* approach proposed by Bennett et al. is not the solution. The land industry needs rather to be developing appropriate tools for users across the spectrum, including the poor, women and men, and in different regions of the world, not just for the developed world, as outlined in their article.

### INFORMAL SETTLEMENTS

What needs to be developed is a pro-poor land-administration system (LAS) of completely different design, interoperable with current cadastral systems. This technical gap needs to

be filled for a range of purposes, including:

- forest management
  - wetland management outside the register
  - customary tenure with layers of group rights
  - informal settlement inventory in preparation for upgrading
  - large-scale identification of land rights and claims following natural disaster, including multiple households inhabiting same dwelling unit, as a pre-cadastral step
  - development of claims database in post-conflict environments, including overlapping claims.
- To take this further, Bennett and co-authors illustrate challenges to the cadastre in the developed world, ▶

which misses one of the greatest challenges to any country's cadastral system: informal settlements. By 2030 the urban population of all developing regions, including Asia and

## Design tools for global society, not just the developed world

Africa, will far outweigh the rural. This massive shift towards urbanisation over the next twenty years will be characterised by informality, illegality and unplanned settlements. Urban

growth will be associated with poverty and slum growth. Today about one third of urban residents in the developing world live in slums which either lie outside the cadastre or the occupation of which does not match it.

### PRO-POOR

Meeting this challenge requires collaborative research focused on the urban and rural poor, rather than just the developed world. FIG has seen this gap and been extensively engaged with UN-HABITAT, Delft University and ITC (Netherlands) in developing the Social Tenure Domain Model (STDm), a pro-poor land-information management system under evolution

by the Global Land Tool Network partners. RICS, also part of this network, is working on how to value unregistered land, to help poverty-stricken widows. In most developing countries only about 30% of land is registered. The challenge facing the land industry is to design tools for the whole range of global society, not just the developed world. This is the only way towards stable, well managed cities and sustainable urban development. The current accurate parcel-based approach proposed by Bennett and co-authors provides only part of the solution. A linked pro-poor LAS, of completely different design, needs also to be put in place to ensure sustainable urban development.

## Working Together



**Dorine Burmanje**, the executive board of Cadastre, Land Registry and Mapping Agency (Kadaster) of the Netherlands, and is president of EuroGeographics.

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**Martin Salzmann** is director of strategy with Kadaster, and actively involved in the development of e-government and SDIs in the Netherlands and Europe.

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It's a pleasure to reply to a positive and ambitious view on the future of cadastres. Our organisation, Kadaster (the Netherlands Cadastre) is in the process of updating its mid-term policy plan up to 2015; so already thinking beyond 2014! In common with our partner organisations within Europe, the Netherlands recognises many of the trends described by Bennett and co-authors, some of which have already been put into action.

### SCARCE RESOURCES

Fundamental to changing the role of cadastre are limited resources. Scarcity

of land and its natural resources, smaller budgets and tighter efficiency controls in relation to growing public and private interests lead to more complex social decisions. Opportunities are offered by the added value of (spatial) information and related technological developments which enable integrated decision making. Using as basis the existent scarce land resource, Kadaster has already developed into a mature and well maintained information system. In the future the 'traditional' cadastre will provide a strong foundation for integrating and linking spatial information. An example is the inclusion of the parcel as core spatial element in INSPIRE. We are experiencing increasing integration of our cadastral information with other spatial and non-spa-

tial components (Figure 1), emphasising the importance of working together and maintaining strong relationships with existing stakeholders. We see this as the key to future success.

### INTERRELATED ORGANISATIONS

At the moment we frequently co-operate with new parties, helping improve our services. We also facilitate other users in both the public and private sector in serving their customers. So the cadastre of tomorrow is about creating a network or web of interrelated organisations and communities. Making processes interoperable forms the basis for successful e-government. In the Netherlands we have just embarked on a major public-sector programme for sharing and distributing spatial information. Many opportunities exist for cadastres in addition to those sketched in *Beyond Cadastre 2014*; however, implementation within our processes and institutional settings will pose many challenges. Kadaster looks forward to moving beyond 2014, and to sharing experiences and learning from counterparts. We want to stay involved and contribute to discussions on the cadastre of tomorrow.

► Figure 1, Example of integrating cadastral data with other geo-information in the Netherlands.



## Time Will Tell



**Daniel Roberge**, director of the Office of the Surveyor General of Québec, has been involved in the design, development and implementation of two national land reforms: that of the Quebec cadastre, which covers all privately owned land in Quebec, and modernising registration of rights on public land

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I found the invitation to comment on *Beyond Cadastre 2014* very opportune and timely because, as chair-elect of FIG Commission 7 (Cadastral and Land Management), I am currently elaborating a work plan for the coming four years, focusing on cadastral perspectives. Further, my organisation, Foncier Québec, will soon have to redesign its cadastral systems; we'll have to foresee a sustainable way of managing our land-rights infrastructure.

### SURVEY ACCURACY

When we started the Cadastral Reform Program in Quebec in 1992, there were people who thought us crazy to undertake resurvey of all the four million private parcels while others were making the shift to a digital cadastre through digitising, compiling and rubber-sheeting their parcel plans at much lower cost (Figure 2). Today, with the development of eGovernment and the 'Spatially Enabled Society' intensively based on cadastral data, we are convinced our decision was the right one. For developed countries I do agree with the 'survey accuracy' design element. But developing countries, where the need for land-rights infrastructure is primary and resources are scarce, require light and low-cost solutions creating exact rather than accurate data.

### OBJECT-ORIENTED AND 3D/4D

Bennet et al. and the co-authors of *Cadastral 2014* agree that future

cadastres will integrate much more than cadastral data; they will manage not only land parcels but also all rights, restrictions and responsibilities (RRR) affecting the territory as independent objects. This laudable target will be hard to concretise, as it implies many jurisdictions. The constraint lies not at technical, but at administrative level. Existing technologies can manage the task, but how do we coerce public bodies such as municipalities and ministries into registering RRR in one register? Legislation alone will not suffice without human and financial resources. Indeed, there are few national examples of comprehensive RRR registers. The one in Quebec covers only RRR relating to the public domain. Switzerland has recently adopted legislation to implement such a register at national level. Time will tell to what extent the vision for Cadastre 2014 is adopted by individual nations. A proliferation of condominiums and superimposed rights and restrictions

in large cities make obvious the need for 3D cadastres. Nevertheless, what are in use are mainly indirect solutions, thanks usually to technological constraints. Advances in technology management should soon make feasible the third and fourth dimensions, with all attendant RRR repercussions, but integrating this into legal and administrative processes will not be easy.

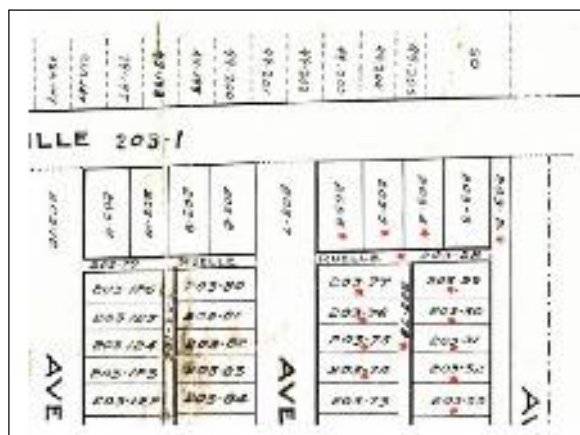
### REAL-TIME AND GLOBAL

Like many organisations in developed countries, we face a shortage of resources and will have to cope with this to achieve our future mission. The way we manage the national land-rights infrastructure has to be redesigned to simplify, streamline and accelerate registration. So the development of intensive automated and online processes, eliminating human intervention whenever possible, will continue.

The link with regional and global networks is desirable, but the challenge will be funding. Each jurisdiction is responsible for internally managing its local or national land-rights infrastructure, not linking it with that of neighbours. If networking is needed, federal or regional government will have to contribute funding to rally its partners around such project. Propositions put forward by both *Cadastral 2014* and now *Beyond Cadastre 2014* represent very good targets. Will they be achievable? Time will tell. But FIG Commission 7 will continue to challenge and develop these proposals.

<sup>1</sup>Foncier Québec is a sector of the Ministère des Ressources naturelles et de la Faune (Department of Natural Resources and Wildlife) responsible for the cadastre and land-rights registration covering both private territory and public land. Québec is the largest of the ten Canadian provinces, with an area of almost 1.7 million square kilometres. Most of the land (92%) is under public ownership. ▶

▼ Figure 2, Quebec made the shift to a digital cadastre through resurvey of all four million private parcels; shown is the 1910 plan of Notre Dame de Quebec Banlieue (top) and the resurveyed plan.



## Two Worries



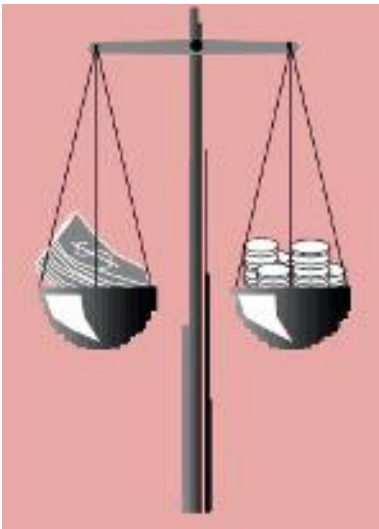
**Paul van der Molen** is visiting professor at Twente University Faculty for Geoinformation Science and Earth Observation (ITC) and former head of Kadaster International.

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As the year 2014 comes ever closer we realise that *Cadastre 2014* is about to have run its course. Who would have thought in 1994 that time would go that fast.....? Thanks to our Melbourne colleagues we can get going on a dialogue about what cadastres will look like when the magic year 2014 has flown. Knowing that a majority of countries are still struggling with the introduction and development of any form of land-information system ('cadastre'), one might ask what the big issues are 'beyond 2014', or better, 'now and beyond 2014'... I am worried about two major things, namely the lack of transparency in the land sector, and a lack of economic justification for investment in cadastres.

### CORRUPTION

The first worry is that the land sector appears to be corrupt through and through. Elites obstruct or manipu-



► *Cadastre 2014 will be highly privatised! Public and private sector will be working closely together!*

◄ *Cadastre 2014 will be cost-recovering!*



late the cadastre; cadastral data fail to reflect situations on the ground; cadastral data are misused and neglected by governments. Whatever

in their land, and do new land owners have better access to credit? It cannot always be proven. Other reports, such as the 2009-WB report

## *Land sector appears to be corrupt through and through*

cadastre we develop, it will become obsolete if not trusted by the people. Here we are touching on the power structures in society, land governance, state land management, personal ethics. Only over recent years have these things been so openly discussed. Continuing along this path will certainly open up new and socially beneficial opportunities for sound cadastral systems.

### LACK OF INVESTMENT

The second worry relates to the investment needed to develop '2014 and beyond' land-administration systems, and the prerequisite justification: that they can generate good returns. Some assessment studies cast doubt on whether there is indeed a return on investment in cadastre. Do people invest more

on Central Europe, sing a sweeter song. Qualitative reasons for the development of cadastres are plentiful; see, for example *Benefits of Land Administration*, WPLA, 2005. However, quantitative reasons are scarce. What is the effect of a good cadastre on land-market dynamics, and what is the contribution to GDP? How do peoples' feelings about security of land rights relate to economic growth? They are certainly good enough, all those ideas put forward by Rohan, Mohsen and Abbas: 'survey accuracy', 'property objects', 'height and time', 'real-time updating', 'regional and global', and 'fuzzy and organic' - but to give them a chance of becoming reality my worries first need to be laid to rest.

## Conclusions

What may be concluded from the expert replies to the six design elements proposed by scientists of the University of Melbourne? The initiative is highly appreciated, and FIG is encouraged to take the lead, together with research institutes, in developing how cadastral should operate in 2034 based on extrapolations of ongoing societal and technological developments. It seems the six chosen design elements emerged from considering highly urbanised areas in developed countries where societal needs can be summed up in three key words: accuracy, detail (3D, 4D, RRR) and real-time. Further, globalisation forces adjustment of cadastral content based on transnational interoperability criteria, while a shift is proposed in modelling boundaries of natural phenomena such as rivers, shores and forest, from crisp to fuzzy. However, completely different societal needs arise in developing countries, and design elements for these areas cannot be drawn up with anything like such steady hands.

How can cadastral contribute to eradicating poverty (a main Millennium Development Goal) and corruption? How can they enforce sustainable development of land? Underpinned by the seminal work of De Soto, received opinion now holds that poverty eradication in rural areas can be achieved by formal registration of land belonging to small farmers, enabling them to invest through a mortgage. This assumption may, however, be challenged; small farmers have a low production capacity which will continue to fall as globalisation progresses. Within one or two generations adjacent farmlands now owned by hundreds of small farmers will probably be swept together into one big property parcel. Farmers' children will move to the cities and the small farmer become extinct. So there's not much sense in investing great effort in improving security of

*Table 1, Urban and rural areas, developed and developing countries, each need vision, approach and solutions of their own.*

	Urban	Rural
Developed	Objects (3D, 4D)/survey accuracy and RRR. Exploiting advanced technology.	Parcels/survey accuracy and RRR. Exploiting advanced technology.
Developing	Determination of role in society. Supporting good governance. Getting cadastral off the ground. Objects (3D)/survey accuracy. Society first, technology next.	Determination of role in society. Supporting good governance. Getting cadastral off the ground Parcels/general boundaries. Society first, technology next.

tenure in areas which will always remain rural. In stark contrast is the situation at urban fringes, where the city meets the countryside. Here farmers face the threat of ejection from their land with little or no compensation, and it is of the utmost importance that security of tenure is established here.

## *An abundance of complicating issues in developing countries*

There is no such thing as 'one-size-fits-all'. There are urban areas and rural areas. There are developed and developing countries. In developed countries the needs of society seem clearer and finding solutions a matter of organising scarce resources, properly applying technology, and anticipating technology to come. Much more challenging tasks face the cadastral in developing countries, where there is an abundance of complicating issues. Here it is not just a matter of cadastral aiming to support a relatively frictionless society, but also enabling creation of a better one; eliminating malnutrition, gender inequality, illiteracy, corruption, and the immense gap between the haves and have-nots. So that's at least four sizes, each requiring specific approaches and solutions; summarised in Table 1.

Here in Part II, Clarissa Augustinus confirms the above, stating: 'The challenge facing the land industry is to design tools for the whole range of global society, not just the developed world'. From a global perspective, the six design elements are far from comprehensive. She thus seamlessly joins her argument to that of Keith Bell, who challenges Bennett and co-writers, asking (see Part I): 'Are real-time, spatially accurate cadastral more important than water, sanitation and nutrition?' Daniel Roberge too recognises that the 'survey accuracy' design element is more a thing for developed countries, as 'developing' countries, where the need for land-rights infrastructure is primary and resources are scarce, require light and low-cost solutions' creating exact rather than accurate data. Paul van der Molen also has an eye for the gap between developed and developing countries, and again sharpens the focus: 'Do people invest more in their land, and do new landowners have better access to credit?' His point is that issues of corruption and lack of return on investment must be resolved before the six design elements have any chance of getting off the ground in developing countries.

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