A New Zealand Strategy for Cadastre 2034

Don GRANT, Mark DYER, Anselm HAANEN, New Zealand

Key words:

Cadastre, Cadastral Strategy, Survey Technology, Spatial Technology, 3D Cadastre, Dynamic Datum

SUMMARY

New Zealand has an AAA (accurate, authoritative and assured) digital cadastral system, based on a modern geodetic system and supporting a digital land registration system. Landowners in New Zealand have a high level of confidence in cadastral boundaries.

Despite these achievements, it is clear that the current cadastral system will not be optimal for the next 10 – 20 years. The rapid development of positioning and geospatial technology, together with increasing expectations of the general public to be involved and well informed, mean that changes will be required.

A cadastral strategy has been developed to prepare for changes over the next 10 – 20 years. This matches the visionary date of 2034 which has been proposed for an update of the FIG Cadastre 2014 strategy.

The New Zealand strategy proposes a number of significant changes to the cadastre. These include broadening the scope of the cadastral system to cover the boundaries and extents of all rights restrictions and responsibilities in land and real property, and making information readily consumable by the general public. This will require the cadastre to be fully three dimensional (3D) as well as responsive to changes over time, so that cadastral information matches the four dimensional world in which people live.

A New Zealand Strategy for Cadastre 2034

Don GRANT, Mark DYER, Anselm HAANEN, New Zealand

1. INTRODUCTION

The critical role of the land-based property rights system in supporting growth in the economy is increasingly well recognised in New Zealand. De Soto (2003) essentially argues that developed countries are rich because they have well developed property rights systems. These encourage good investment and enable the creation of capital for further development and innovation.

Similarly, there is increasing recognition of the contribution that location based information can make to the government's social, economic, and environmental objectives. The cadastral system lies at the conjunction of property rights and location based information - supporting growth and national well-being.

At the same time, advances in consumer technology are increasing the expectations of ordinary people that they should be kept well informed about matters that affect them – such as their land-based rights, restrictions and responsibilities. People will increasingly have access to good positioning technology and tools for combining and visualising location-based information.

These changes may very quickly result in the New Zealand cadastral system not meeting the needs of the Crown, Māori, government agencies, holders of rights and interests in land, businesses, and society generally.

The strategy (LINZ 2013a), which is described in this paper, provides a clearly stated vision towards which anticipated future demands can be met by efficient investment and collaborative effort. Earlier strategies have been focused on the needs of surveyors and government agencies. While these are still important, this strategy is also very much focused on the needs of ordinary people – citizens, landowners, investors, etc.

Actions are already underway to realise the vision for the New Zealand cadastral system.

2. STRATEGIC CONTEXT

2.1 FIG Cadastre 2014 and Cadastre 2034

The vision of Cadastre 2014 (Kaufman and Steudler, 1998) was developed by a working group of the International Federation of Surveyors (FIG) from 1994 to 1998. Bevin (1999) assessed developments in New Zealand, including the integrated automated survey and title system known as *Landonline*, and concluded that New Zealand was well on the way towards achieving the objective statements. Hirst (2010) also assessed the progress of Australia and New Zealand towards the objectives of Cadastre 2014 and proposed an update to the vision.

Kaufman (2012) discusses the movement towards FIG acceptance of a view of Cadastre 2034 and variations in terminology such as "cadastre" and "land administration". Lemmens (2010) reviewed the global progress towards 2014, through responses from 10 experts, and proposed that FIG take the lead in developing a vision of how cadastres should operate in 2034. It was suggested that this be based on six features proposed by Bennett et al (2010).

These features, which are reflected within the New Zealand Cadastre 2034 strategy, are: **survey accurate** to facilitate layering of different spatial datasets; **object oriented** towards property objects rather than parcels; **3D/4D** to align with other 3D and time variant datasets; **real time** to support continuous access and updates; **global** to align with international standards and best practice; and **organic** to model rights, restrictions and responsibilities based on the natural environment.

de Rijcke and Hunter (2013) reviewed the New Zealand consultation document *A 10-20 year strategy for developing the cadastre* (LINZ, 2012) and identified similar needs in Canadian jurisdictions. They identify three general principles for custodians of cadastral information which the New Zealand 2034 vision supports:

- Governance must be citizen-centric - aimed at the needs of citizens rather than (necessarily) the outputs of surveyors.
- Open and transparent governance - enabling citizens to inform themselves through open access to information.
- Facilitating innovation – ensuring that there are opportunities for public and private innovation – especially for data that serves a public good.

2.2 New Zealand Policy Framework

2.2.1 Government's Information Policy

New Zealand has a Geospatial Strategy (LINZ, 2007) which includes doing things once to an agreed standard, and then making that information available to apply across a wide range of applications. This is consistent with government's declaration on open and transparent government (Government CIO, 2013) which governs the availability and release of government data. To support this declaration, the government asserts that the data and information it holds on behalf of the public must be open, trusted and authoritative, well managed, readily available, without charge where possible, and reusable, both legally and technically. Personal and classified data and information must be protected.

2.2.2 ICSM National Strategy for Cadastral Reform & Innovation

The Intergovernmental Committee on Surveying and Mapping (ICSM), which New Zealand is a member of, is currently developing a National Strategy for Cadastral Reform and Innovation for Australia. This strategy (ICSM, 2013) is still in draft form but is aligned with the New Zealand strategy. Both the New Zealand and Australian strategies are aimed at 2034 and both share the same vision statement (discussed in section 4.1 below) while recognising

the different complexities in Australia with federal jurisdictions, each with independent legislation and governance of their cadastral systems.

2.2.3 LINZ 10 Year View

Land Information New Zealand (LINZ) is developing a 10 year view of its future direction (LINZ, 2013b). This is aimed at the areas where the department can apply focus, funding and people to the greatest benefit for New Zealand. This 10 year view puts location information at the heart of the strategic direction. A key component is the concept of a "location system" which will enable diverse location enabled information sets to be merged to gain new knowledge, provoke better decisions and inspire innovation.

New Zealand's property rights system will clearly be a significant part of this location system – by enabling New Zealanders to relate the intangible legal spaces (boundaries within which rights, restrictions and responsibilities apply) with the tangible 3 dimensional and dynamic world in which people make important decisions related to the use of land and real property.

2.3 New Zealand Cadastral System

2.3.1 Fundamental Cadastre

In this strategy the term 'fundamental cadastre' is used to describe the repository of cadastral survey datasets lodged with LINZ and integrated into its database, and which are regulated by legislation. These are the base cadastral units (Williamson et al, 2010) underpinning the property rights system and comprise the primary land parcels as well as secondary parcels such as easements.

2.3.2 Broader Cadastre

There exist other rights, restrictions and responsibilities (RRR) in land which are created and managed in terms of other legislation or rules of law and which are not clearly part of the fundamental cadastral system. Some examples are:

- licenses, such as for mining
- Land use consents and designations (generally public works or those of network utility operators)
- rights to maintain public drains on private property

These all impact on a landowner's use and enjoyment of their land and arguably do fall within the description of the property rights system. The term 'broader cadastre' is used to describe the repository of data and information about the extents and boundaries of these other rights, restrictions and responsibilities

2.3.3 Characteristics of the Current Cadastral System

The management of the cadastral system in New Zealand is governed by legislation. Legal boundaries are defined by physical evidence. Coordinates record the position in the spatial

database but they are highly variable over time, and in their accuracy in relation to the physical evidence of boundaries, reflecting the historical method of boundary capture of individual surveys. Coordinates are also affected by earth deformation. Coordinates have minimal legal standing in the fundamental cadastre because the common law of boundary definition assigns high evidential weight to undisturbed boundary marks.

The spatial database within *Landonline* is, in essence, two dimensional. Changes over time also occur as new information comes to hand. This new information is most commonly new cadastral survey datasets but changes are also made as a result of the integration of new geodetic data, including in response to deep seated ground movement as in the recent Canterbury earthquake events.

There are different tenure systems in New Zealand for recording RRRs. For example, Crown land rights are dealt with differently from rights held in titles under the land registration system, which are dealt with differently from rights to Crown Minerals. RRRs related to such matters as electricity transmission lines or public drains are generally not available through the cadastral system unless they are registered as easements.

2.3.4 Maori Rights in Land

The effective utilisation of Māori land is important for social, cultural and economic wellbeing. Māori also have customary methods for managing RRRs. Increasingly, modern spatial techniques are being used to assist the management of not only Māori land but also other traditional resources. Any recording of culturally sensitive information, including waahi tapu (sacred places), in the broader cadastre needs to be appropriately managed.

The concept of kaitiakitanga (exercise of customary guardianship) is increasingly embodied in statute. The cadastral system of the future should be sufficiently flexible to enable the fulfilment of Māori aspirations and Treaty of Waitangi obligations, and so return benefits to Māori and New Zealand generally.

2.3.5 Dynamic Management of Coordinates

New Zealand's position across the boundary of tectonic plates means that it is faced with the challenges of a dynamic earth influencing coordinates and boundaries as they change over time. Consequently there needs to be a means of relating the spatial extent of rights at the time they were created to their current position.

The cadastral survey system therefore depends on a modern and effective national geodetic system in order to make the connection between the social and legal purpose of creating and defining the extents of RRRs, and the dynamic earth (the land) on which they are situated. Advances in positioning technology, combined with research in geophysics, are expected to increase our ability to model the earth and its dynamics, enabling certainty in three dimensions to be maintained over time. This will help maintain confidence that the up-to-date locations of digital boundaries recorded in the cadastre are aligned with the real world boundary positions.

2.3.6 Heights and a Three Dimensional Cadastre

Most rights do not have any specified height limits despite their application in a three dimensional (3D) world. However, increasingly boundaries are being defined in three dimensions to cover rights in multi-storey buildings, underground environments (including tunnels, passageways), and airspace. 3D rights are recorded using plan graphics (see Figure 1) rather than 3D objects.

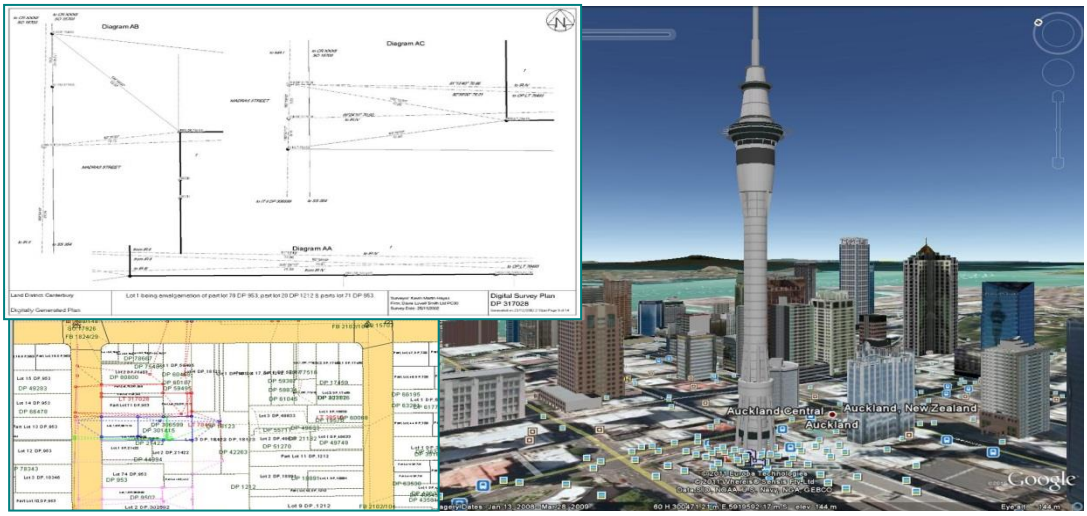

Figure 1: Recording, Depiction, and Visualisation of 3D rights in 2D formats

There is currently no standardised digital way of representing 3D objects in cadastral datasets other than by the traditional drawings of plans, sections, and elevations. Users increasingly expect land and building developments and associated rights to be digitally accessible and viewable in 3D.

2.3.7 Relating Legal Spaces to the Physical World

The traditional method of providing a physical representation of boundaries has been by the placement of boundary pegs. However such boundary marks are not used for many lesser rights such as easements and covenants, and they cannot be used in some situations (particularly for 3D rights). In some cases physical features such as buildings are used to define the boundary. The future cadastre will need to enable people to relate legal spaces to the physical world in more dynamic ways.

3. STRATEGY DEVELOPMENT

3.1 Process

An early decision was made to develop the strategy in a broadly consultative manner. This reflected the view that the cadastre is not only relevant for cadastral surveyors but is critically important to a wide range of stakeholders and the public.

Two workshops with a reference group were held and a consultative draft strategy was prepared (LINZ, 2012a). Feedback was sought from the public generally via the LINZ website (including an on-line forum), as well as engaging with a wide range of stakeholders.

A total of 37 written submissions were received as well as discussion in the on-line forum, reflecting careful consideration given to the issues, potential benefits, and possible solutions. The vast majority of submitters were positive and in support (Grant and Dyer, 2012).

3.2 Feedback and Key Issues

All submissions were reviewed in detail and a summary published on the LINZ website.

Main points raised were:

- A need to clearly define 'cadastre' and 'cadastral system' and their component parts including suggestions for data modelling, data management and data interchange
- Linking the cadastre to international standards to assist addressing issues of interoperability and user interfaces
- Strong support for maintaining primary focus on the fundamental cadastre and caution that broadening the cadastre including the use of Volunteered Geographic Information, may undermine the integrity and confidence in the fundamental cadastre.
- Maori land should be included and suggestions made about 'interests' in relation to physical features or non-parcel boundaries
- Crown land is currently considered difficult to deal with and lacks the efficiencies that apply to general land
- Improving accessibility to information about rights to minerals, if not the mineral deposits themselves
- Support for the broader cadastre and in particular the inclusion of land uses, buildings, geotechnical information, and natural hazard restrictions
- The success of the strategy requires sustainable funding and several submitters said that the costs should be borne by beneficiaries and not just those transacting.

4. STRATEGY

4.1 Vision

Following analysis of submissions, and giving some consideration to the emerging Australian strategy (ICSM, 2013), the final vision presented in the strategy is:

> ***A cadastral system that enables people to readily and confidently identify the location and extent of all rights, restrictions, and responsibilities related to land and real property.***

To achieve this vision:

- People will need accurate spatial positioning (expected to be delivered by advances in technology)
- People will need easy access to accurate and trusted spatial information on all relevant boundaries
- People will need information technology that enables them to visualise this boundary information relative to the real world or spatial information about the real world (expected to be delivered by advances in technology)
- The spatial accuracy of information about boundaries will need to match the needs of landowners and others for the definition of boundaries
- The cadastral system will need to receive and maintain information on boundaries to the required confidence levels

The strategy identifies a series of goals that need to be achieved in order to realise the vision.

4.2 The Goals

4.2.1 Goal 1 – Maintain public confidence as the cadastral system is developed

Whatever changes and enhancements are made to the fundamental cadastre, the Surveyor-General is required to ensure that the public continue to have confidence in the integrity of the system. The system must be well governed, protected from emerging risks and future-proofed to accommodate new rights and needs of society.

For the vision to be achieved for all RRRs, this public confidence will also be extended to the broader cadastre. These other RRRs affect people's use and enjoyment of land. The confidence required for the less regulated RRRs in the broader cadastre may be at a different level but, to maximise the potential of the property rights system, governance, protection and future-proofing will be extended at an appropriate level to these broader RRRs.

Three sub-goals have been identified in relation to achieving this primary goal of maintaining public confidence.

Sub goal 1a – Governance

An appropriate governance structure will ensure that a strategic approach is taken to the management and development of the cadastral system, providing benefits to all stakeholders over the long term. Sustainable funding models will be in place based on, and derived from, the broader cadastral system.

The cadastral system will be sustained professionally. This is particularly important for the fundamental cadastre but also applies to the management of the broader cadastre. Active leadership is provided from within the surveying profession. Surveyors and other land-related practitioners will be engaged, and cadastral surveying will be valued and attractive ensuring that skills and knowledge will be maintained.

Sub goal 1b – Disaster protection and security

The cadastral system will be safe from interference or disaster over the very long term. Records with enduring value (whether digital or paper based) will be preserved, protected and recoverable. Security systems will prevent unauthorised access and change. The system will be recoverable following physical damage or disaster.

Sub goal 1c – Research and future-proofing

Research on cadastral systems will ensure that the system can respond to emerging needs and risks – especially those resulting from new technology. The research will be strategically driven and funded, benefitting from collaboration where possible.

4.2.2 Goal 2 – The cadastre includes the extents of all rights, restrictions and responsibilities

The RRRs relating to land and real property will be identified and appropriate information about their boundaries will be accommodated within the cadastral system. All types of tenure (Crown, Māori, General, minerals, local government, etc.) will be in the cadastre. The cadastral system makes clear what rights are included.

4.2.3 Goal 3 – Complete spatial representation of rights, restrictions and responsibilities

The cadastre will include the boundaries of RRRs in a form that allows them to be visualised in relation to each other.

Five sub-goals have been identified in relation to achieving this primary goal of achieving completeness of the spatial representation.

Sub goal 3a – All boundaries of rights, restrictions and responsibilities are spatially represented

All boundaries of the RRRs in the fundamental cadastre that currently only have a graphical or textual description, will be upgraded to be spatially represented. In addition, all other rights in the broader cadastre will also have a spatial representation of their boundaries.

Some types of RRRs in the fundamental cadastre are not fully spatially represented, while some RRRs in the broader cadastre do not have spatial representation of their boundaries.

This will be addressed in part, by the development and implementation of policies and rules for the spatial depiction of all RRRs, including the back capture of existing RRRs that lack spatial representation.

Sub goal 3b – The accuracy of spatial representation matches the accuracy of the boundaries

The quality of spatial representation recorded in the cadastre will match the accuracy

standards of the defined boundaries of the RRRs. Goal 4 addresses the accuracy standards of the defined boundaries. Spatial accuracy standards will be developed, especially for accuracy, for boundaries in the broader cadastre.

Sub goal 3c – Rights, restrictions and responsibilities can be spatially represented in three dimensions

Even though most rights have traditionally been captured in 2D form, they will be capable of being represented in a form that enables encroachments and conflicts at different heights to be readily identified.

The cadastre will allow the modelling of the spatial extents of RRRs, including those with defined height limits, to be closely related to the 3D physical world e.g. buildings, mines, air space, water space.

Current systems are not sufficient to transfer, manage, and visualise 3D data. NZ Vertical Datum 2009 is not a vertical datum of sufficient accuracy and usability to support all RRRs.

Actions include: the development and implementation of a geodetic strategy that supports a dynamic 3D cadastre (including a dynamic datum); improvement in the accuracy of the vertical datum and geoid model to support 3D RRRs; and development of a system of dynamic coordinates so recorded positions match those on the ground, whether caused by slow ground movement or catastrophic deformation. Tools will be developed to create, transfer, manage, visualise and depict 3D cadastral data.

Sub goal 3d – Changes in rights, restrictions and responsibilities over time can be spatially represented

New RRR's are created and existing RRR's extinguished or modified over time. The spatial representation will reflect these changes to RRRs over time including enabling an historic view at any time. The retention and management of all data relevant to the broader cadastre over time will be encouraged.

Sub goal 3e – The spatial representation of rights, restrictions and responsibilities reflects changes in location over time

Some boundaries based on natural features may move continuously with that feature e.g. public access strips along water boundaries. In these cases the spatial representation will reflect the information currently available on that feature and the historical location. The spatial representation of title boundaries based on natural features will only move when the title is updated.

Changes in location arising from tectonic earth movement whether slow and continuous or as a result of earthquakes may result in boundaries moving. The spatial representation of boundaries will respond to available geodetic information enabling the location to be determined at the time the right was created or at any subsequent time.

4.2.4 Goal 4 – The quality of the boundaries of rights, restrictions and responsibilities matches the need

The quality of the boundaries of RRR's will be fit for purpose. Different accuracies, supported by standards, will be used, depending on such factors as the type of environment and risk of conflict e.g. rural v urban v maritime boundaries; underground utility services in urban areas; restrictions related to cultural or heritage values; etc.

4.2.5 Goal 5 – The cadastral system efficiently receives information from sources with appropriate levels of trust

The spatial representation of RRRs in the fundamental cadastre will have tightly controlled sources and processes to ensure standards are met. In the case of the broader cadastre more flexibility may be appropriate.

The means of capture will be efficient, making the best use of technology. The source will be identified, allowing an indication of confidence. In all cases, principles of transparency, liability, and competency will be applied.

There is currently a lack of adequate validation tools relevant to the source, especially for third party use (for data from both trusted sources and other sources). Non-*Landonline* databases do not have access to live *Landonline* data, resulting in duplicated effort to maintain those databases. There is a lack of suitable systems for holding the data and unknown authority and reliability of cadastral data in the broader cadastre, especially where the data is not from a trusted source.

Actions include: the development of readily accessible validation tools for non-fundamental data, and the development of systems for holding non-fundamental cadastral data (from both trusted and other sources). This may require change in legislation.

4.2.6 Goal 6 – People have access to cadastral data which is able to be integrated with other data

Cadastral information will be readily available in real-time through channels that meet user needs. The delivery mechanisms will be sufficiently flexible to take advantage of technology and changing societal demands.

This does not mean that LINZ will necessarily be the holder of all information. Rather it suggests that a user can access information on the location of RRRs from multiple sources, perhaps through tailored portals.

Any conflicts or uncertainty within the cadastre will be identified and transparent. Access to data will be limited only by security, privacy, and cultural sensitivity principles.

Key actions identified include researching geospatial standards including ISO 19152:2012 and, if necessary, developing principles and standards to enable non-spatial linkages between datasets. A system of dynamic coordinates will also be a key action to achieve this goal.

Custodians of cadastral data will make it readily available to third parties and each other, consistent with the geospatial strategy (standards, interoperability, stewardship principles, etc). Custodians will also ensure that the public have access to cadastral data that can be integrated through channels and interfaces that meet user needs. Protocols will be developed so users understand the completeness or otherwise of the data in relation to RRRs.

4.3 Initial Activities and Progress

Running in parallel with the development of the New Zealand Cadastre 2034 strategy are a number of other significant initiatives within LINZ. These are broadly consistent with the strategy and will develop business cases for specific developments. Those business cases, if approved by government, will contribute towards the implementation of the Cadastre 2034 strategy and realization of its vision and goals.

4.3.1 Better Property Services

Better Property Services (LINZ, 2013c) is a Ministerial priority identified in the LINZ Statement of Intent 2013-2016 (LINZ 2013d) which sets the 4 year strategic direction for the department. This project involves working across government agencies that have a role in management of land and property related services including the provision of information.

The Better Property Services vision is for integrated provision of government-mandated location-based property information and services. This would enable anyone seeking to buy, sell, build, renovate, develop or live on a property to access the information and services they need via a service that shows all the RRRs for that property. This future would provide a seamless customer experience, based on integrated, up-to-date, digital and location-based information, even though the supporting backroom functions may be separately managed.

This will not only encompass the fundamental cadastral and land registration systems managed by LINZ, but also other land-based property related services such as consents for resource management (land development) and building consents. The collaboration between government agencies will identify the benefits of a cross-government service and provide a coherent and unified government policy framework for the broader cadastral system.

This initiative will contribute to the actions in the strategy to provide a cross agency policy direction, governance, funding and collaboration to advance a New Zealand property rights system that extends beyond the fundamental cadastre to the broader cadastre.

4.3.2 Advanced Survey & Title Services

LINZ's, *Landonline* system (Haanen et al, 2002), has transformed the survey and title systems of New Zealand (Muir and Armitage, 2013). Since 2007, 100% of cadastral survey and land registration transactions have been lodged in electronic form including structured attribute data. The processing and registration of 85% of land registration transactions is fully automated and all other cadastral and title transactions have automated business rules applied to assist approval.

Nevertheless, the system faces some challenges. The technology is becoming outmoded and has not kept up with customer IT environments. The user interface does not meet modern expectations and enhancements to the system are slow and expensive (ibid).

LINZ is developing an indicative business case to government to develop the system. The preferred option will provide for greater interoperability with other property and location information systems, improve the user interface including greater compatibility with surveyor's software, make provision for 3D cadastral capabilities and will improve access to information in other tenure systems such as Crown land and Māori land (ibid).

This initiative will contribute to the actions in the strategy to provide for 3D cadastral information, enhance validation tools for cadastral survey data, and improve the linkages between the cadastre and other tenure systems.

4.3.3 Digital Parcel Improvement

The *Landonline* programme included a survey conversion project to upgrade the spatial accuracy of 70% of the land parcels in New Zealand to meet the accuracy standards of the applicable survey regulations (Rowe, 2003). This capture was aimed at providing significant processing efficiencies for new cadastral survey datasets, and focused on urban and peri-urban areas which provided the best cost/benefit ratio. The remaining 30% of parcels however, make up 50% of all boundary corners and cover almost 95% of the New Zealand land mass.

The spatial accuracy of the unimproved digital parcels is variable and uncertainties in the range of 10-100 metres are not uncommon (LINZ 2013e). Improvements in spatial accuracy occur in a slow and uncoordinated manner as new cadastral surveys are lodged and integrated into the system. It is estimated that without increased investment in people, tools and methodologies, it will take many decades to upgrade the bulk of the remaining 30% of parcels to survey accuracy. LINZ is therefore preparing an indicative business case (LINZ 2013e) for funding to improve the spatial accuracy to provide survey accurate digital parcels in high priority areas and to meet the coverage required by current and future users.

This initiative will contribute to the actions in the strategy to ensure that the spatial accuracy of digital boundaries matches the accuracy standards for survey definition.

5. CONCLUSIONS

New Zealand was an early adopter and implementer of the FIG Cadastre 2014 vision (Kaufman and Steudler 1998; Bevin 1999). New Zealand has begun working towards the updated vision in Cadastre 2034, even before 2014 arrives.

LINZ has recognised the significant contribution that can be made to New Zealand's future growth through the development of a location system in general and the property rights system in particular. LINZ is actively working across agencies to establish the policy and governance frameworks and is developing business cases for government support for the needed developments including those of a broader cadastre.

The vision, goals and actions identified in the strategy will not be easily achieved. However Cadastre 2034 is seen as a challenging but achievable target for the New Zealand cadastre.

REFERENCES

Bennett, R., Rajabifard, A., Kalantari, M. (2010) *Cadastral futures: building a new vision for the nature and role of cadastres.* FIG Congress 2010: Sydney, Australia:

Bevin, A.J. (1999) *Cadastre 2014 Reforms in New Zealand.* Presented at NZIS Conference, Bay of Islands, New Zealand. http://www.linz.govt.nz/sites/default/files/docs/surveysystem/survey-publication/cadastre2014reformsinnz.pdf

de Rijcke, I. and Hunter, A. (2013) *A Vision for the New Zealand Cadastre: Insights for Canadian Jurisdictions.* Geomatica, 67(3), 181-184.

De Soto, H. (2003) *Mystery of capital: why capitalism triumphs in the West and fails everywhere else.* Basic books.

Government CIO, (2013) *Declaration on open and transparent government.* http://ict.govt.nz/programmes/open-and-transparent-government/declaration-open-and-transparent-government

Grant, D.B. and Dyer, M, (2012) *A 10-20 Year Strategy for Developing the Cadastre: Knowing the Extent of Land-Related Rights.* Presented at NZIS Conference, Invercargill, New Zealand.

Haanen, A., Bevin, T., Sutherland, N. (2002, April) *e-Cadastre-Automation of the New Zealand Survey System*. Presented at FIG 2002 Congress, Washington USA

Hirst, B. (2010) *Cadastre 2014, Australia and New Zealand, now and the future.* Proceedings, FIG Congress 201, Sydney, Australia.

ICSM (Intergovernmental Committee on Surveying & Mapping), (2013) *Cadastre 2034 – Powering Land and Real Property: Cadastral Reform and Innovation for Australia – A National Strategy*. http://www.icsm.gov.au/cadastre2034/feedback/Strategy_Consultation.pdf

Kaufman, J. (2012) *Towards Cadastre 2034.* Proceedings International FIG Symposium & Commission 7 Annual Meeting, Innsbruck, Austria.

Kaufman, J. and Steudler, D. (1998) *Cadastre 2014: A vision for a future cadastral system.* International Federation of Surveyors, Switzerland

Lemmens, M. (2010) *Towards Cadastre 2034.* GIM International, 24(9) and 24(10).

LINZ (Land Information New Zealand). (2007) *A New Zealand Geospatial Strategy.* http://www.linz.govt.nz/docs/geospatial-office/nz-geospatial-strategy-2007.pdf

LINZ (Land Information New Zealand). (2012) *A 10-20 Year Strategy for Developing the Cadastre: Knowing the Extent of Land-Related Rights – Consultation Document.* http://www.linz.govt.nz/sites/default/files/docs/Consultation-Document-12-10-2012.pdf

LINZ (Land Information New Zealand), (2013a) *Cadastre 2034: A 10-20 Year Strategy for developing the cadastral system: Knowing the 'where' of land-related rights.* http://www.linz.govt.nz/sites/default/files/docs/cadastre_strategy_web4.pdf

LINZ (Land Information New Zealand), (2013b) *The power of "where" drives New Zealand's success: The 10 year view for Land Information New Zealand.* (in preparation).

LINZ (Land Information New Zealand), (2013c) *Better Property Services.* http://www.linz.govt.nz/about-linz/news-publications-and-consultations/consultation-projects-and-reviews/better-property-services

LINZ (Land Information New Zealand), (2013d) *Statement of Intent 2013-2016.* http://www.linz.govt.nz/sites/default/files/about-linz/news-publications-and-consultations/corporate-publications/statement-of-intent/soi_2013.pdf

LINZ (Land Information New Zealand), (2013e) *Digital Parcel improvement Indicative Business Case.* (in preparation)

Muir, R. and Armitage, C. (2013) *New Zealand Survey and Title System – Repositioning for the Future.* Presented at 2013 International Land Titles Conference, Vancouver, Canada

Rowe, G. (2003) *The survey conversion project–making a survey-accurate digital cadastre for New Zealand a reality.* New Zealand Surveyor, 293

Williamson, I, Enemark, S, Wallace, J, Rajabifard, A. (2010) *Land Administration for Sustainable Development* ESRI Press Academic.

BIOGRAPHICAL NOTES

Don Grant was the New Zealand Surveyor General until February 2014 when he took up the position of Associate Professor in Geospatial Science at RMIT University. He holds a BSc Honours in Physics from Canterbury University, a Diploma in Surveying from Otago University and a PhD in Surveying from the University of New South Wales. He registered as a surveyor in 1979 and is a Licensed Cadastral Surveyor.

Mark Dyer is a Registered Professional Surveyor and was Director of Canmap Hawley Limited until April 2014 when he took up the position of New Zealand Surveyor-General. He holds a Bachelor of Surveying from the University of Otago, and a Post Graduate Diploma in Resources and Environmental Planning from the University of Waikato. He is a Licensed Cadastral Surveyor, and a Past President and Fellow of the New Zealand Institute of Surveyors.

Anselm Haanen is the New Zealand Deputy Surveyor-General. He holds a Master of

Surveying degree from the University of Otago, obtained registration in 1983 and is a Licensed Cadastral Surveyor. He has provided advice on Land Information Systems and spent 2 years in Fiji as Advisor to the Fiji Land Information System. More recently he was technical leader in the build of the Landonline survey-accurate cadastral database.

CONTACTS

Dr Don Grant
Associate Professor in Geospatial Science
RMIT University
GPO Box 2476
Melbourne, Victoria 3001
Australia
Tel. +61 3 9925 2424
Email: donald.grant@rmit.edu.au
Web site: http://www.rmit.edu.au