The Requirements for Point Cadastres

Robert ANTWI, Ghana; Rohan BENNETT, Walter DE VRIES, Chistiaan LEMMEN, Co Meijer; The Netherlands

Key words: point cadastres; single point cadastre; land administration

SUMMARY

This paper reintroduces the point cadastre: a cadastal system where geographic points are used to represent land parcels. When point features are combined with satellite imagery, freely available topographic maps (e.g. OpenStreetMap), and managed using cloud based geographic information services, a simple cadastral solution becomes apparent. This paper concentrates only on defining requirements for point cadastres. Three discrete studies were used to generate the requirements: expert group meetings, a pressure cooker meeting, and an online questionnaire. The requirements are classified under preparation, functional, quality, and architectural categories. Preparation requirements illustrate the need for contextual awareness before commencing any point cadastral project. Functional requirements are found to be similar to the requirements of parcel based cadastres, however, the necessity for parcel boundary identification is removed. Quality requirements promoted the need for 'ease of use' and 'low cost'. Architectural requirements provided various options for collecting, storing, maintaining, and visualizing the cadastral point information. Together, the requirements provided deliver a basic blueprint for land administrators considering point cadastre solutions. This is a significantly shortened version of a paper submitted to an academic journal.

The Requirements for Point Cadastres

Robert ANTWI, Ghana; Rohan BENNETT, Walter DE VRIES, Chistiaan LEMMEN, Co Meijer; The Netherlands

1. INTRODUCTION

In recent times, the parcel-based nature of cadastres has been challenged. Classical definitions of 'cadastre' make mention of records relating land parcels, parcel boundaries, and associated descriptions of property rights (FIG, 1995; Kaufmann and Steudler, 2001; Williamson *et al*, 2010). However, new concepts and tools advocate for more flexible cadastral units: work on 3D cadastres adds a third dimension to parcels (Stoter and Salzmann, 2003); the LADM (Land Administration Domain Model) (van Oosterom et al, 2006) and STDM (Social Tenure Domain Model)(FIG, 2010; Griffith-Charles, 2011) allow point or line based property RRRs (rights, restrictions, and responsibilities); and work on Organic Cadastres suggests new legal and graphical descriptions might be required for representing the property rights of nature in cadastral systems (Bennett et al, 2010). In short, a range of new property object types is contesting the 2D parcel.

This paper is concerned with point representations of property, or *point cadastres*. Point cadastres use a single geographical coordinate to represent a parcel or land interest in a cadastre. The concept is also referred to as dots-for-plots, single point cadastres, or geocoded address files. The focus is not on accurate surveying of boundaries, but on providing a basic spatial reference of land tenures (i.e. 1 coordinate per parcel). Adjudication of boundaries can occur at a later time- when and if it economically feasible to do so. Meanwhile, the single point cadastre can be used to enable rudimentary land administration functions such as: land tenure recognition, land taxation, land use planning, and other government activities.

The drive for this approach emerges from the developing context: many cadastres in these places are incomplete or in need of renewal. Existing establishment approaches are too expensive in terms of time and cost (Toulmin, 2009, AMCHUD, 2005; Fourie et al, 2002; Osterberg, 2001; UN-ECA, 1999; Schermerhorn and Witt, 1953): the potential benefits of a reasonably complete cadastral system are not being realized practice (Barnes, 2003; Griffith-Charles, 2002). Approaches that are more cost efficient, faster to implement, and more fit-for-purpose are required (c.f. Barnes et al, 1994; Hanstad, 1998; Haldrup, 2004; Potsiou and Ioannidis, 2003). Point cadastres enable adjudication, surveying, demarcation, and recordation processes to be expedited.

The point cadastre concept is not new: numerous conceptual and practical examples can be found in land administration literature (Dale and McLaughlin, 1988; Larsson, 1991; Burke, 1995; Holstein, 1996; Durand-Lasserve, 1997; Home and Jackson, 1997; Jackson, 1997; Fourie, 1998; Davies, 1998; Torhonen and Goodwin, 1998; Fourie and Nino-Fluck, 1999; Latu, N.D.; Van Oosterom et al, 2006; Lemmen et al, 2007; FIG, 2010 (or Lemmen (2010)). What is new however, are the emerging spatial tools that enable improved establishment and maintenance of point cadastres (and cadastres in general). These include: high-resolution satellite imagery (HRSI); low-cost and higher-precision hand-held GNSS receivers; LADM and STDM standards, and cloud-based information storage, visualization and analysis tools. When combined, these tools provide could provide for rapid and low-cost establishment of basic cadastral systems.

The UNU School for Land Administration Studies at The University of Twente and Kadaster International are currently undertaking exploratory work on point cadastres. The work is focused on updating and continuing earlier studies on point cadastres (Dale and McLaughlin, 1988; Larsson, 1991; Holstein, 1996; Durand-Lasserve, 1997; Home and Jackson, 1997; Jackson, 1997; Fourie, 1998; Davies, 1998; Torhonen and Goodwin, 1998; Fourie and Nino-Fluck, 1999; Latu, N.D.; Van Oosterom et al, 2006; Lemmen et al, 2007; FIG, 2010 (or Lemmen, 2010)). The aim is to determine how previously identified requirements, design, and implementation methods can be updated based on technological developments and changing drivers. The paper presents a selection of results from these studies. Specifically, it reports on results from requirements gathering exercises. The overarching methodology is described. Results from each part of the process are then provided. The derived requirements are discussed in terms of *preparatory, functional, quality,* and, *architectural* requirements.

2. METHODOLOGY

The requirements gathering exercise was part of a broader set of studies intended to develop, design, and test contemporary approaches for point cadastres. The broad set of studies included: conceptualization activities, requirements gathering activities, and realization activities. This paper focuses solely on requirements gathering. The *requirements* gathering phase included an expert discussion, pressure cooker meeting, and online questionnaire. Each activity was a discrete study and followed recognized procedures, however, results from each activity fed into subsequent activities.

The *expert discussions* involved the researchers interacting with land administration practitioners on two occasions (5 people in total) for several hours each time. A research diary was kept throughout to document notes and observations. The *pressure cooker* meeting was more focussed and included a group discussion (c.f. Kumar, 2005; Gray, 2004) with technical managers and staff from Netherlands Kadaster (7 people in total). Only limited time (2 hours) was provided with the aim of generating reasonably firm requirements at the conclusion of the meeting. The *online questionnaire* aimed to validate the ideas and identified requirements from the earlier studies; however, the focus was primarily on the qualitative requirements of a point cadastre.

A limitation of the first two studies, and possibly the questionnaire was the inability to engage with those from contexts where point cadastres could be implemented. Any steps towards further implementation would certainly require such engagement. However, it should be noted that members of the expert discussed held decades of project experience in contexts where point cadastres might be applicable.

The requirements formalization phase synthesized results into *preparatory*, *functional*, *quality*, and *architectural* requirements. These are well-recognized requirement categories in design-based disciplines such as engineering and computer science. No formalized synthesis methodology was adopted: the researchers used previous system design experience and basic trend analysis. Each category is now examined.

3. REQUIREMENTS FORMALIZATION

The results from the discrete studies are synthesized under four categories of requirement: *preparatory*, *functional*, *quality*, and, *architectural* requirements.

3.1 Preparation Requirements

Preparation requirements are essential: the necessity for a point cadastre should be determined before establishment. A range of approaches can be used to structure preparation requirements. Here, adapted versions of Henssen (2010) and PESTLE (Aguilar, 1967; Turner, 2002) are used. Table 1 describes the factors that must be assessed, recorded, and understood prior to commencing any point cadastre project.

Table 1. Preparation Requirements

Analysis item	Specific issues to consider
Political	Governance context; government structure; land administration organizations
Economic	Economic basis; financial stability and growth; public sector and private sector interactions; financing options
Social	Levels of professionalism, education, and health; types of land uses
Technological	Existing infrastructures (hard and soft); existing data sources
Legal	Land laws, regulations and tenures
Environmental	Topography; natural resources; levels and locations of degraded lands

3.2 Functional Requirements

Functional requirements relate to the purpose of the point cadastre. They explain what the point cadastre must do as a product and a process. Functional requirements for point requires are presented using an adapted version of Henssen's (2010) generic functions of a cadastre or land registration system (Table 2).

Table 2. Functional Requirements

Function	Tasks	Description
Establishment	Adjudication	• Must enable the articulation of adjacent (or overlapping land tenures) • Location of boundary lines is not required
	Demarcation	• Must physically demarcate land tenures in a simple way. For example, marking a building with an address or ID number. • Existing features can be used (e.g. trees) for demarcation • Demarcation can also be virtual (e.g. retraceable grid coordinates)

	Surveying	• Utilize either ground or aerial methods of survey. • Can be considered to use general boundaries: a single point approximates a parcel and its boundaries.
	Recordation	• Should store results from adjudication, demarcation, and surveying in some form of information system. • Graphical (e.g. cadastral point map) and textual elements (tenure information) should be recorded. • No boundary records are required, however, spatial referencing should be sort. • The two types of information should be linked. • An underlying high-resolution image or topographic map should be added to the system to provide contextual information.
Maintenance and Renewal	As above	• Should enable establishment tasks (adjudication, demarcation, surveying and recordation) to be repeated in a sporadic fashion for data upgrading and system upgrading.
Multipurpose	Land Tenure	• Should enable very basic spatial recording of land tenures
	Land Taxation	• Can allow for simple land valuation and taxation assessment and enforcement
	Land Planning and Development	• Combined with other sources of data can support infrastructure decision making (e.g. acquisition), land use planning decision-making and enforcement.
	Other	• After basic land administration functions are implemented, point cadastre can be utilized for governance of health, education, and other social requirements.

3.3 Quality Requirements

Qualitative requirements were extracted from the expert discussion and pressure cooker meeting. In most cases it is not possible to achieve all qualitative requirements: a system of ranking is required. For this reason the qualitative requirements are ranked. This was done using the results of the online questionnaire. Table 3 provides the required qualities, descriptions, and ranking in relation to point cadastres. Defining measurable indicators requires for these qualitative requirements requires further work.

Table 6. Quality Requirements

Quality	Definition	Rank
Ease of use	Level of technical/specialized capacity to build and maintain the point cadastre	1st
Cost	Costs of technical equipment, human resources, supplies, etc., in producing and maintaining the point cadastre database	2nd
Time/Speed	Time required to initially develop and maintain the point cadastre	3rd
Flexibility	Capacity of the point cadastre to be used across different agencies by many stakeholders	4th
Scalability	Ability of the system to be extended for use at regional and national levels (i.e. increasing the types of data collected, spatial coverage, allowing for concurrent users)	5th
Accuracy	Refers to spatial accuracy of the points collected (i.e. the closeness of the positions of objects in the point cadastre to the positions on ground)	6th

3.4 Architectural Requirements

Architectural requirements or physical components of the point cadastre are described in Table 7. Elements are organized around the ideas of Henssen (2010) and Lemmen (2011). It should also be noted that the two central components of all cadastral systems (whether be it parcel based or not) are present here: spatial and non-spatial information. As such, each element provides requirements and techniques for spatial and non-spatial data capture (c.f. Schermerhorn and Witt, 1953; Silayo, 2005), storage, maintenance, and visualization.

Table 7. Architectural Requirements

Architectural Element	Items	Tools
Data Collection	Spatial	• Low-end GNSS receiver (e.g. Trimble Juno) • Office based heads-up digitizing of imagery • Field based heads-up digitizing (e.g. tablet computer) • Field sketches (pen and paper) • Use of high-end GNSS, plane tables, or total stations is considered to undermine low cost, high speed approach
	Attributes	• Low-end mobile data storage device (e.g. Trimble Juno) • Office based heads-up data entry • Field based heads up digitizing (e.g. table computer) • Field notes (pen and paper)
Storage	Database	• Object-relational database (potentially based in the cloud) • Relational database (potentially based in the cloud) • Paper based system
	Data Structure	• Somewhat dependant on database approach • Immediate focus should be on simplicity (e.g. a single layer) • Tools must enable linking spatial points and associated attribute information (e.g. simple IDs, various people types, land uses, land tenures, land values, and potentially other multipurpose data)
Maintenance	Editing tools	• Basic tools for: adding, moving, and removing points; for changing and removing attribute information; for querying spatially and by attributes (potentially based in the cloud)
Visualization	Base Layer	• Imagery of low-cost and high-resolution to enable contextualization of individual points (e.g. Ikonos, Quickbird) • If available, use of topographic map base (e.g. OpenStreetMap)
	Points Attributes	• Simple spatial viewer overlaying points and base imagery • Same tool as for points with viewing options for imagery (e.g. frontage or people) and audio data (potentially for illiterates)
Field Infrastructure	Ground Control and Spatial Reference System	• A limited number of reasonably well positioned ground control points (potentially CORS stations), however, requirement for limited spatial accuracy (e.g. +/5m) mitigates need for extensive ground control • If GNSS utilized, requirement for datum transformation and coordinate conversion procedures – must fit into national reference network
	Survey Marks	• Coordinates and signage (e.g. address or parcel ID) preferred over physical markers (e.g. concrete pillars)

4. CONCLUSIONS

This paper reintroduced the point cadastre: a cadastral system where geographic points are used to represent land parcels. When combined with high-resolution satellite imagery and stored in a geographic information system, a simple cadastral solution becomes apparent. This paper concentrated only on requirements for point cadastres. Three discrete studies were used to generate the requirements: expert group meetings, a pressure cooker meeting, and an online questionnaire. The formalized requirements were classified under preparation, functional, quality, and architectural categories. Preparation requirements illustrated the need for contextual awareness before commencing any point cadastral project. Functional requirements were found to be similar to the requirements of parcel based cadastres, however, the necessity for parcel boundary identification was removed. Quality requirements promoted the need for ease of use and low cost: accuracy was found to rank lowest out of the six quality requirements. Architectural requirements provided various options for collecting, storing, maintaining, and visualizing the cadastral point information. Options for field infrastructure were also provided. The requirements provided can provide a framework for land administrators considering point cadastre solutions. Further work is required: the requirements needed to be implemented in a more realistic testing. This work is ongoing between the UNU School for Land Administration Studies at The University of Twente, and Kadaster International.

ACKNOWLEDGEMENTS

The authors wish to acknowledge that this paper is a greatly abstracted version of a paper submitted to an academic journal. They also wish to acknowledge the support of colleagues at the UNU School for Land Administration Studies, ITC Faculty, University of Twente. in the development and review of this work.

REFERENCES

Aguilar, F.J., (1967), *Scanning the business environment*, Macmillan, New York, United States.

AMCHUD. (2005). *Innovations in Africa: pro-poor land approaches.* Paper presented at the Arican Ministerial Conference on Housing and Urban Development, Durban, South Africa.

Barnes, G. (2003). Lessons learned: an evaluation of land administration initiatives in Latin America over the past two decades. *Land Use Policy*, 20(4), 367-374.

Barnes, G., Moyer, D. D., & Gjata, G. (1994). Evaluating the effectiveness of alternative approaches to the surveying and mapping of cadastral parcels in Albania. *Computers Environment and Urban Systems, 18*(2), 123-131.

Bennett, R., Kitchingman, A., Leach, J. (2010). On the nature and utility of natural boundaries for land and marine administration, *Journal of Land Use Policy*, 27(3), doi:10.1016/j.landusepol.2009.10.008

Burke, L. (1995). Urban and Municipal GIS Applications in Developing Countries - the Problems and the Potential, *Esri International User Conference*. Retrieved from http://proceedings.esri.com/library/userconf/proc95/to300/p271.html

Dale, P., and McLaughlin, J.D. (1988). *Land Information Management*, Clarendon Press.
Davies, C., (1998). *Land management for an informal settlement in East London*, Msc thesis (unpublished), University of Natal.
Durand-Lasserve, A. (1997). *Innovative practices regarding the provision of infrastructure and services, tenure regularisation and new relationships among urban actors*, iKusasa.
FIG. (1995). *FIG Statement on the Cadastre*. Retrieved October 3, 2011, from http://www.fig.net/commission7/reports/cadastre/statement_on_cadastre.html
FIG. (2010). *The Social Tenure Domain Model- A Pro Poor Land Tool*, FIG Publication 52, UN-HABITAT, GLTN, Copenhagen, Denmark.
Fourie, C. (1998). *An integrated geo-information system with emphasis on cadastre and land information systems for decision makers in Africa*, working document for the expert group meeting held at United Nations Economic Commission for Africa, Addis Ababa, Ethiopia, 23 – 26 November 1998.
Fourie, C. and Nino-Fluck, O., (2000). Cadastre and Land Information Systems for Decision Makers in the Developing World, *UN-FIG Conference on Land Tenure and Cadastral Infrastructures for Sustainable Development*, Melbourne, Australia, October 25-27, 1999. Paper published in Geomatica, 54 (2000): 335 – 342.
Fourie, C., van der Molen, P., & Groot, R. (2002). Land management, land administration and geospatial data: exploring the conceptual linkages in the developing world. *In: Geomatica*, 56(2002)4, 351-361.
Gray, D. E. (2004). *Doing Research in the Real World*: SAGE Publications.
Griffith-Charles, C. (2002). *Designing effective cadastral reform : Trinidad and Tobago*. Paper presented at the XXII FIG International Congress and ACSM-ASPRS Conference and Technology Exhibition
Griffith-Charles, C. (2011). The application of the social tenure domain model (STDM) to family land in Trinidad and Tobago. *Land Use Policy*, 28(3), 514-522.
Haldrup, N. O. (2004). *Land Registration in Developing Countries – An Introduction.* Aalborg University.
Hanstad, Y. (1998). Developing land registration systems for developing countries, *American University International Law Review*, 13(3).
Henssen, J., (2010), Land registration and cadastre systems: principles and related issues, Lecture Notes, Masters Program in Land Management and Land Tenure, TU Munchen, Germany.
Holstein, L. (1996). *Towards Best Practice from World Bank experience in Land Titling and Registration*. Washington DC: World Bank Consultant.
Home, R., & Jackson, J. (1997). *Our common estate : land rights for informal settlements : community control and the single point cadastre in South Africa*. The Royal Institution of Chartered Surveyors, London, United Kingdom.
Jackson, J., (1997). Boundary-less cadastral systems: A possible role for fuzzy sets in the South African cadastre, iKusasa, *CONSAS*, Durban, 24-28 August, 1997.
Kaufmann, J., & Steudler, D. (2001). *Cadastre 2014 : a vision for a future cadastral system* (Second edition ed.). S.l.: International Federation of Surveyors (FIG).
Kumar, R. (2005). *Research methodology : a step - by - step guide for beginners* (Second edition ed.). London etc.: Sage.
Larsson, G. (1991). *Land Registration and Cadastral Systems: Tools for land information and management*. Longman Scientific and Technical.
Latu, T.S. (N.D). *Modelling a land information system for freehold and customary land tenure systems, Department of Land Information*, RMIT Centre for Remote Sensing and GIS, Occasional Paper Series, No. 95/1.
Lemmen. (2010). *Social tenure domain model : a pro - poor land tool* (Vol. 52). Copenhagen:

International Federation of Surveyors (FIG).
Lemmen, Augustinus, C., Oosterom, P. v., & Molen, P.v.d. (2007). The social tenure domain model: design of a first draft model. Paper presented at the *FIG Working week*.
Osterberg, T. (2001). What Is An Appropriate Cadastral System In Africa*?* Paper presented at the *International Conference on Spatial Information for Sustainable Development*. Nairobi, Kenya, Oct 2-5.
Potsiou, C. A., and Ioannidis, C. (2003). Low Cost Technologies and Techniques in Implementing Cadastral and Spatial Information Management Infrastructure. *2nd FIG Regional Conference*. Retrieved: http://www.fig.net/pub/morocco/proceedings/ts23/ts23_1_potsiou_ioannidis.pdf
Schermerhorn, W., and Witt, G. F. (1953). Photogrammetry for cadastral survey. *Photogrammetria*, *10*(0), 45-57.
Silayo, E. H. (2005). Searching for an Affordable and Acceptable Cadastral Survey Method. Paper presented at the *FIG Working Week 2005 and GSDI-8*. Retrieved from http://www.fig.net/pub/cairo/papers/ts_39/ts39_03_silayo.pdf
Stoter, J., and Salzmann, M., (2003), Towards a 3D cadastre: where do cadastral needs and technical possibilities meet?, *Computers, Environment and Urban Systems*, Volume 27, Issue 4, July 2003, Pages 395-410.
Törhönen, M.P. and Goodwin, D.P., (1998). Would a registry map hang comfortably in a round mud hut? A register of title for Zimbabwe's communal areas: philosophical and technical considerations. *Australian Surveyor* 43 (2).
Toulmin, C. (2009). Securing land and property rights in sub-Saharan Africa: the role of local institutions - 2. *Land Use Policy 26*(1), 10-19.
Turner, S., (2002) *Tools for success: a manager's guide*. McGraw Hill, London, United Kingdom.
UN HABITAT. (1990). *Guidelines for The Improvement of Land-Registration and Land-Information Systems in Developing Countries (with special reference to English-speaking countries in Eastern, Central and Southern Africa).* Nairobi, Kenya.
UNECA. (1999). An integrated geo-information system with emphasis on cadastre and land information systems for decision makers in Africa. *UN. ECA Committee on Development Information Meeting*, 1999, June 28- July 2 : Addis Ababa, Ethiopia. Retrieved from http://hdl.handle.net/123456789/4158
Van Oosterom, P.J.M., Lemmen, C.H.J., Ingvarsson, T., van der Molen, P., Ploeger, H., Quak, W., Stoter, J., and Zevenbergen, J., (2006), The core cadastral domain model, *Computers, Environment and Urban Systems*, Volume 30, 5.
Williamson, I., Enemark, S., Wallace, J., and Rajabifard, A. (2010). Land Administration for Sustainable Development. FIG International Ccongress 2010, Sydney, Australia, 11-16 April,2010, Publisher - ESRI Press Academic.

BIOGRAPHICAL NOTES

Robert Antwi is a cadastral surveyor from Ghana. Between 2010 and 2012 he completed an MSc in Geo-Information Science and Earth Observation (Land Administration). His thesis work focused on utilizing emerging geospatial tools to build low cost and time efficient cadastral systems.

Rohan Bennett is an Assistant Professor at the UNU School of Land Administration Studies at the University of Twente. He holds Bachelors degrees in Geomatics and Information Systems, and completed his PhD (Land Administration) in 2007 at The University of Melbourne.

Walter de Vries is an Assistant Professor at the UNU School of Land Administration Studies at the University of Twente. He lectures and researches in subjects such as institutional, organizational and economic aspects of geoinformation, strategy and management of geoinformation organizations and geoinformation infrastructures. Holding an MSc degree in geodetic engineering from the Technical University of Delft, he has worked since 1988 in a number of international projects in Asia, Africa and South America, often dealing with land information and land reform, geospatial data infrastructures and professional training and education.

Christiaan Lemmen holds a degree in geodesy from Delft University of Technology, The Netherlands. He is an assistant professor at the Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente The Netherlands. He is senior geodetic advisor at Kadaster International, the international branch of the Netherlands Cadastre, Land Registry and Mapping Agency. He is vice chair of the Working Group 7.1 on 'Pro Poor Land management' of FIG Commission 7, 'Cadastre and Land Management', and a contributing editor of GIM International. He is director of the FIG International Bureau of Land Records and Cadastre OICRF.

Co Meijer has worked for over 30 years with Dutch Kadaster. He has worked in land consolidation, land registration, and cadastral and topographic mapping. Co also holds 10 years experience in ICT management services in the same organization. He has experience in all areas of the organization. Co holds an MSc degree in Social Geography from the University of Utrecht. Since 2006 he has been a manager with Kadaster International and based in the Netherlands. Co has extensive experience in land administration projects and is focused on Africa. Project experiences include Uganda, Rwanda, Lesotho, Namibia, South Africa, Guinea-Bissau, and many other countries. He is focused on low cost data collection solutions and developed the idea for point cadastres as a starting point for building land administration systems.

CONTACTS

Mr. Robert Antwi
University of Twente
ITC - UNU School for Land Administration Studies
Enschede 7500 AE
NETHERLANDS
Tel. +31 (0)53 4874 339
Fax + 31 (0)53 4874 575
antwi21925@itc.nl

Dr. Rohan Bennett

University of Twente
ITC - UNU School for Land Administration Studies
Enschede 7500 AE
NETHERLANDS
Tel. +31 (0)53 4874 339
Fax + 31 (0)53 4874 575
bennett@itc.nl

Ir. Walter de Vries
University of Twente
ITC - UNU School for Land Administration Studies
Enschede 7500 AE
NETHERLANDS
Tel. +31 (0)53 4785377
Fax + 31 (0)53 4874 575
devries@itc.nl

Ir. Chrit Lemmen,
University of Twente / Kadaster International (Netherlands Kadaster)
ITC - UNU School for Land Administration Studies
Enschede 7500 AE
NETHERLANDS
Tel. +31 (0)53 4874523
Fax + 31 (0)53 4874 575
lemmen@itc.nl

Mr. Co Meijer,
University of Twente / Kadaster International (Netherlands Kadaster)
ITC - UNU School for Land Administration Studies
Apeldoorn
NETHERLANDS
co.meijer@kadaster.nl