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Good e-Governance and Cadastral Innovation: In Pursuit of a Definition of e-Cadastral Systems

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Abstract

The development and implementation of an e-cadastre, called Project Vulindlela, is underway in South Africa yet there is little literature/research to guide e-cadastral development and implementation globally. Also, the meanings of the terms 'e-cadastre' and 'e-cadastral system' are unclear. This paper seeks to address these limitations. We begin with a look at definitions of key terms in the field of cadastral development. Then an understanding of what constitutes an e-cadastral system is formed through an exploration of: good governance as related to cadastral development, e-government and e-governance, and a study of global cadastral and land administration trends and 'future cadastres'. The e-cadastral system is thereafter defined as an electronic, parcel-based land tenure information system (LTIS) that combines the roles of the agencies in control of surveys and mapping, land registration, land valuation and land use / development in a manner that aims to broadly satisfy e-governance outcomes as related to cadastral systems development. Finally, the implied goals of the e-cadastral system are described. It is hoped that this exploration will stimulate further development of the concepts of e-cadastral systems such that formal critique of these systems will be possible in the future.

1. Introduction

Traditionally cadastral information systems have been paper-based (Borzacchiello & Craglia, 2012). These records have comprised of two parts: a legal description (e.g. title/deed) and a numerical/diagrammatic description (Zevenbergen, 2002). These are often housed separately and managed by different government institutions resulting in a duplication of information and unnecessarily increasing complexity and costs of accessing land information. The global trend over the last two decades has been to migrate from paper-based information systems to digital information systems in order to improve efficiency and accessibility of information (Borzacchiello and Craglia, 2012). This is realised in the modernisation of cadastral, land information, and land administration systems and the design and implementation of electronic cadastres, now termed 'e-cadastres'. Some of the most influential concepts in this regard are: Cadastre 2014, Cadastral Futures, Cadastre 2.0, the Social Tenure Domain Model (STDM), the Land Administration Domain Model (LADM) (Augustinus *et al*., 2006; Bennett *et al*., 2010; Jones and Land, 2012; Kaufmann and Steudler, 1998; Lemmen *et al*., 2013a; Lemmen, 2010, 2012; Uitermark *et al*., 2010; van Oosterom *et al*., 2006), and subsequent related works.

1.1 Motivation and purpose

The motivation for the paper comes firstly from Barry and Roux (2012, p. 302) who state that "there is a dearth of critically developed theory which has been subjected to rigorous testing in LTIS [Land Tenure Information Systems], but no lack of practical guidelines on what constitutes best practice." Secondly, there is great variety in operational definitions in use in land administration theory with limited consensus: "Incompatible definitions may render [theoretical] comparison unworkable" (*ibid*, p. 306). The purpose of this paper is to explore a definition of e-cadastral systems based on relevant literature as a precursor to the development of theory in LTIS: "clear definitions and descriptions of constructs and the relationships between them form the essence of good theory" (*ibid*. p. 306, but note also the discussion that opens Section 2).

Drawing on the theory taxonomy devised by Grover and Glazier (1986), as adapted by Barry and Roux (2012), the proposal put forward herein is pitched at both the construct / concept and definition levels. This is a desktop study of cadastral theory informed by theories of change management, systems theory, cadastral theory, visions for the future cadastre, concepts of e-government and e-governance, and performance measurement. E-cadastral systems are hence herein defined in association with their relationships to these other constructs. It is hoped that this exploration of e-cadastral systems and their goals will provide tools for those involved in land administration and cadastral development to promote good governance.

1.2 Outline

This paper begins with a definition of important terms as a means of clarifying understanding of concepts. An investigation into the current understanding of the principles of good governance in cadastral systems and land administration follows. The key principles of good governance are summarised. They underpin the arguments for modernisation of cadastral systems and are strongly linked to cadastral systems reform in practice. From good governance we move to a summary of e-government and e-governance and explore the links between these concepts. Concepts of the cadastre of the future are then described, drawing on some of the more significant publications over the last couple of decades. Four concepts of ideal future cadastral systems are hence derived. Finally, the meaning of e-cadastral systems is synthesised in a formal definition.

2. Defining Terms

It is important, at the outset, to define the main terms used in this paper. In the field of modernisation of cadastral systems, terminology is diverse and in some cases undifferentiated. Researchers and practitioners tend to adopt and use whatever terms they are most familiar with, while the reader is left to interpret the meaning thereof through the subtext and argument. Silva and Stubkjær (2002, p. 418) state that there is a need for "a body of basic theory of cadastral systems which includes a definition of concepts that may serve world-wide applications." Çağdaş and Stubkjær (2009) motivate for standardisation and consensus. In their development of the LADM, Lemmen *et al.* (2013b, p. 27) describe as one of the goals of the model the "establishment of a shared ontology [to enable] communication between involved persons". Tjia and Coetzee (2013),

with reference to Hess and de Vries (2006), affirm that, without common vocabulary, alternative cadastral systems developed in different contexts hinder the exchange of data, especially across national borders, while adopting internationally recognised vocabulary improves communication about land administration. Conversely, Barry and Roux (2012, p.305) caution that standardisation may "stifle critical thinking and innovation". In this article the authors have embraced the need for a common understanding of e-cadastral systems, and hence standardisation, through proposing a definition. But Barry and Roux's (*ibid*.) caution should not be ignored and it is noted that working/contextual definitions are equally important. Hence we highlight the following working definitions such that their understood meanings are shared with the reader.

The ***cadastre*** is "a parcel-based, and up-to-date land information system containing a record of interests in land [and] includes a geometric description of land parcels linked to other records describing the nature of the interests" (FIG, 1995, p. 1). Silva and Stubkjær (2002, p. 410) add that it is a "systematic and official description of land parcels, which includes for each parcel a unique identifier [and] includes text records on attributes of each parcel. … The focus of cadastre is spatial, not legal or fiscal." The '***parcel'*** referred to above is a spatial unit of area (or volume), over land or water, "where rights and/or social tenure relationships apply" (Uitermark *et al*., 2010, p. 2). Spatial units support the creation and management of ***basic administrative units – "baunits"*** *(Lemmen et al*., 2013a, p. 30). These are groups of spatial units "against which one or more unique and homogeneous rights …, responsibilities or restrictions are associated to the whole [administrative] entity as included in the Land Administration System" (*ibid*.). From these definitions it is implied that the cadastre does not *only* refer to formal land ownership but the 'parcel', 'interests', and 'attributes' could refer equally to informal and customary land tenure arrangements (although the term "cadastre" is usually linked to formal systems). The ***e-cadastre*** is "the electronic system delivering the services traditionally provided by the Cadastral Office [using] digital cadastral information to provide governmental services to the citizens, business and other [public sector administrations] within an e-Government framework … supported, or not, by the SDI [Spatial Data Infrastructure]" (Borzacchiello and Craglia, 2012, p. 2).

A ***cadastral system*** is "the combination of a cadastre – with its spatial focus – and a land register – with its legal focus" (Silva and Stubkjær, 2002, pp. 410–411), including all aspects of the juridical, fiscal and regulatory cadastres, and developed and assessed considering its political, legislative, economic, technological, and social aspects and relationships (Whittal, 2008). The cadastral system relies on four separate agencies: land tenure (surveying, mapping, and land registration), land valuation (related to taxation), land use control (incorporating spatial planning), and land development (Dale and McLaughlin, 1999; Enemark, 2005; Williamson *et al*., 2010). The definition of ***e-cadastral system*** forms the subject of this paper and is presented in section 6. A ***system*** is here understood as a group of interrelated elements, treated as a whole, working towards a common purpose, and exhibiting properties that are different from those of its requisite parts (see Checkland (1999)).

The base unit of any ***Land Administration System (LAS)*** is the land parcel as identified in the cadastre (Williamson *et al*., 2010). A land administration system includes the functions and operations of the cadastral system, but also higher level integration, management and dissemination of cadastral information and includes the institutions and operations that facilitate this (UNECE, 1996; Williamson *et al.*, 2010). Furthermore, land administration is "the study of how people organise land. It includes the way people think about land, the institutions and agencies people build, and the processes these institutions and agencies manage" (Williamson *et al*., 2010, p. 37). Land administration should be underpinned by the principles of good governance (Enemark, 2012; Whittal, 2011). **"**[A] modern land administration system should … support its core policy of sustainability [and] service the increasing need of businesses for good governance and an enhanced quality of life" (Kalantari, 2008, p. 24).

An ***e-Land administration system*** is the transformation of LAS through the use of information and communication technologies (ICT) with the goal of improving services to citizens through improved integration, management and communication. This is achieved through facilitating "electronic submission and processing of development applications, e-conveyancing, the digital lodgement of survey plans, online access to survey plan information, and digital processing of title transactions as a means of updating the database" (Williamson *et al*., 2010, p. 259).

A ***Land Information System (LIS)*** is an information system that is established and maintained for purposes of land management. The cadastral system is a subsystem of an LIS, which incorporates other subsystems such as the juridical, regulatory, and fiscal cadastral systems (Whittal, 2008). A ***Land Tenure Information System (LTIS)*** is an LIS that emphasises the role of stakeholders and relationships within the LIS and includes the cultural aspects of land and user behaviour (Barry and Roux, 2012).

3. Good Governance in Cadastral Systems

Governance is the process of governing (FAO, 2007; Williamson *et al*., 2010). It refers to "the way in which society is managed and how the competing priorities and interests of different groups are reconciled" (FAO, 2007, p. 5) and "the manner in which power is exercised by governments in managing a country's social, economic, and spatial resources" (Williamson *et al*., 2010, pp. 30–31).

Governance is qualified as 'good' when it adheres to certain interdependent principles (Enemark, 2012; FAO, 2007; Palmer *et al.*, 2009; UN-HABITAT, 2010; United Nations, n.d.; Whittal, 2011; Williamson *et al*., 2010). These are summarised in Table 1. As the present discussion is in the domain of cadastral systems, the principles of good governance *as pertaining to cadastral systems development* are described further. These have been extended from juridical cadastres into the areas of fiscal cadastres and land development by Whittal (2008) and are here grouped under the following four headings: a) Efficient, effective and enduring; b) Transparency, accountability and the rule of law; c) Equity and participation; and d) Security and Integrity (see Table 1). Whittal cautions that these are "ideals rather than achievable objectives [that should] guide and inform the development of land administration initiatives" (2011, p. 171), while Enemark (2012, p. 5) describes good governance as "an ideal which may be difficult to achieve."

Table 1 Descriptors of good governance

	United Nations (n.d.)	FAO (2007)	Palmer et al (2009)	UN-HABITAT (2010)	Williamson et al (2010)	Whittal (2011)	Enemark (2012)
Efficient, effective, enduring	Efficient	Efficient	Efficient	Efficient	Efficient	Accessible, cost-effective, timely, complete, inclusive, maintained	Efficient
	Effective	Effective	Effective				Effective
	Enduring	Sustainable	Sustainable	Sustainable	Sustainable	Sustainable	Sustainable (incl. local responsiveness)
		Competent					Competent
Transparency, Accountability & the Rule of Law	Transparent	Transparent		Transparent	Transparent	Transparent, clear, simple, empowerment	Transparent
	Accountable	Accountable		Accountable	Accountable		Accountable
	Rule of Law	Consistent, predictable, impartial Legitimate	Rule of law			Adherence to international standards, legality	Predictable
Equity and Participation	Equity	Equity	Equitable participation	Equity	Equity	Fairness / equity	Equity and legitimacy
	Participation	Participatory and locally responsive		Civic engagement / citizenship	Civic engagement / citizenship	Local participation	Participatory (incl. security and stability)
	Pluralism						
					Subsidiarity		
Security and Integrity		Security and stability	Tenure security	Security	Security	Security	
		Integrity					Integrity
						Use of world-class ICT	

3.1 Efficient, effective and enduring

An efficient and effective cadastral system must be **accessible**, but with the caveat that cultural sensitivities and legal and privacy issues must be respected (FIG, 1995). Good governance requires that information on the restrictions and benefits associated with a particular spatial unit should be widely available within the public sector (Uitermark *et al*., 2010). Accessibility should also be affordable for would-be users, not wasteful of taxpayers' money, and procedures should be kept clear and simple (Augustinus *et al*., 2006; Williamson *et al*., 2010). Cadastral systems should be "low cost" or operated so that "costs can be recovered fairly and without unduly burdening users" (FIG, 1995, p. 11). Uitermark *et al*. (2010) highlight the role of ICT in reducing the costs associated with land administration although this may decrease accessibility for the poor. Accessible cadastral systems should be free of complex forms, procedures and regulations that would slow down the system and discourage use thereof (FIG, 1995). Whittal (2011) highlights the importance for the

general public to be able to understand the system used if it is to be truly accessible (see also Augustinus et al., 2006).

Sustainability (endurance) is partly ensured through maintenance of the system, beginning with staff skills development. The organisational and management arrangements, procedures and technologies, recruitment of competent staff members and their employment in appropriate government sectors, all need to be appropriate (Enemark, 2012; FIG, 1995; Whittal, 2011). This contributes to the empowerment of citizens. Maintenance also refers to the up-keep of the cadastral data: its currency (age of data), completeness (there should be no gaps in the data), and inclusivity (does the data reflect all potential users or interested parties?). This means the system should include all land parcels (FIG, 1995), including the full spectrum of formal, semi-formal and informal land rights (Zevenbergen *et al*., 2013), and details thereof should be updated as they change. As mentioned previously, this is the ideal to which cadastral systems should aspire. Completeness and inclusivity are not achieved overnight. Until they are, cadastral and land administration systems should be fit for purpose (Enemark, 2012) and development should follow an incremental (*ibid*.), pro-poor approach (Zevenbergen *et al*., 2013).

Good governance is realised when the objectives of government are achieved whilst balancing the social, economic and environmental needs of the nation in a manner that is responsive to the present and future needs of society (Williamson *et al*., 2010): a "long term perspective" is required for sustainable development (Palmer *et al*., 2009, p. 12). This is particularly important in the light of the challenges posed by climate change and rapid urbanisation (Enemark, 2012; Williamson *et al*., 2010): an up-to-date and accessible cadastral system can provide crucial support for land management and administration systems responding to these challenges.

3.2 Transparency, accountability and the rule of law

To ensure that governance meets the standard of being 'good', government decisions and the enforcement thereof must follow rules and regulations – **the rule of law** (Williamson *et al*., 2010) – and adhere to international standards (Whittal, 2011). Good governance requires that no one stands above the law: politicians, officials, professionals and other stakeholders in land must be held **accountable** for their actions (Palmer *et al*., 2009; Whittal, 2011). Good governance requires that information regarding government activities – principles, policies and processes – must be made freely available and accessible to the public (Williamson *et al*., 2010); i.e. government processes and procedures must be **transparent**. Empowerment stems from transparency (Whittal, 2011): when citizens are afforded information about government processes, they are empowered to act appropriately as agents of these processes (see below).

3.3 Equity and participation

Cost-effectiveness, clarity, simplicity, and accessibility are all interrelated goals that work together to ensure that systems of governance are **equitable and fair**. "Fairness also includes providing *equitable access* to the system"; this is achieved through decentralised offices, simple procedures, and reasonable fees (FIG, 1995, p. 11 emphasis added). Objectivity is important in this

regard and the process should be apolitical and responsive to the needs of citizens if it is to be effective (Palmer, *et al*., 2009).

Local input is a means of realising the empowerment of citizens. Whittal affirms that "[t]here should be local input to and local benefits from the system" (Whittal, 2011, p. 171). "Good governance places all [land-related] decisions … upon respect for fundamental human rights and *ensures that all relevant stakeholders are enabled to effectively participate*" (Palmer *et al*., 2009, p. 11, emphasis added). Participation refers to citizens' input into the system. If the system is equally accessible to all citizens without discrimination, taking cognisance of poverty and access to technology, and recognises and protects a variety of forms of land rights, then it meets the criterion of equity. If citizens are empowered through the ability to give their input into the system and make recommendations to government, then the participation criterion is also satisfied. Augustinus (2010) highlights the importance of local input, enabled through the introduction of the Social Tenure Domain Model, in maintaining the currency and accessibility of land information systems.

3.4 Security and Integrity

During the process of governing it is essential that a government ensures that issues of **security** are adequately addressed. In cadastral development this means that land markets, where they exist, must be able to operate effectively and efficiently, financial institutions must have enough faith in the system to mortgage land quickly, and there should be certainty of land ownership and parcel identification (FIG, 1995). This is not always possible in poor areas, for instance due to anti-eviction legislation resulting in banks becoming more cautious.

Allowance needs to be made for the safe storage of cadastral data including backups (*ibid*.). In addition the cadastre should be "tamper-proof" and secure enough to avoid "corruptive adaption" (Whittal, 2011, p. 169) by officials or others seeking to further their own interests: there should be a dedication to **integrity** (FAO, 2007). Security also implies freedom from persecution and forced evictions, which are partially ensured through the provision of land tenure security (Palmer *et al*., 2009; Williamson *et al*., 2010).

Whittal (2011) highlights the use of world-class **technology** as a means of improving good governance in cadastral systems development. ICT is desirable for delivery of security in information systems and to make them tamper-proof (*ibid*.) while also providing for the possible reconstruction of physical datasets lost to fire or flood (Augustinus *et al*., 2006). It should provide a clear and simple platform for accessing and interacting with data, maintaining the completeness and currency of the data, making access to government data fair and equitable, and to reduce the costs to the citizens. Sustainability should be built into ICTs so that their implementation is efficient, effective and enduring. By having access to information regarding government policies and processes, citizens become empowered and transparency is promoted. "Information technology is of strategic importance to be able to deliver systems that can underpin [the] variety of tenures, meet changing customer demands, reduce land disputes, assist in upgrading informal settlements, and improve agricultural production through better land management." (Augustinus *et a*l., 2006, p. 6)

In short, when the *process* of governing is *improved* through the *correct* use of world-class information technology, governance can become 'good' (FAO, 2007). Yet development should follow "a flexible and *fit-for purpose* approach rather than being guided by high tech solutions and costly field survey procedures" (Enemark, 2012, p. 13 emphasis in the original). The technology and its use should be appropriate (FIG, 1995). The inappropriate use of world-class ICT may hinder governance (Augustinus *et al*., 2006), especially in the developing world context, where the infrastructure to accommodate advanced ICT is lacking. There is no one-size-fits-all approach.

4. e-Government and e-Governance

E-cadastre falls under the broad umbrella of e-government and hence the benefits and challenges associated with e-government are expected to be relevant to e-cadastres. ***E-government*** refers to "the use by government agencies of information technologies … that have the ability to transform relations with citizens, businesses, and other arms of government" (The World Bank, 2011). The purpose of utilising these ICTs is to improve the delivery of government services to citizens (G2C), businesses (G2B), NGOs (G2N), and between government agencies (G2G) (Sangita and Dash, 2005) by making such interactions "more friendly, convenient, transparent, and inexpensive" (*ibid*., p. 4).

The benefits of the introduction of e-government are (with reference to Howard (2001) and The World Bank (2011)): reduced costs, increased efficiency, promoting economic development, greater transparency and accountability, improved service delivery and public administration, and a more technologically savvy society (e-Society). The link to good governance, as described in the previous section, should be obvious. Two of the most significant challenges facing the development of e-government processes are the issues of privacy and security (*ibid*.). These must be addressed during the design phase of e-government systems.

The development of e-government follows a series of stages (Layne and Lee, 2001). These have been described differently by a variety of authors (e.g. Basu, 2004; Cloete, 2012; Howard, 2001; Layne and Lee, 2001) yet all of the models describe "a transition from traditional paper-based services to fully digital services, ranging from elementary information provision through digitally enhanced and supported offerings to full inclusion of a public service" (Cloete, 2012, p. 129). The process is highly similar to cadastral modernization processes and is here developed into six stages as follows:

1. Initially, a government process will change from **paper-based to digital data** and thereafter digital data and information can be used by the institution. This involves organisational and procedural change largely driven by modernisation goals.
2. The second stage involves the **sharing of digital data and information** between government institutions (G2G). Vertical integration happens when different levels of government are electronically linked while horizontal integration is defined as integration "across different functions and services" at the same government level (Layne and Lee, 2001, p. 125).

3. The third stage involves **e-communication with the citizenry** in the provision of **information online** in parallel with walk-in service delivery centres. The initial focus by government is in simply establishing an online presence and providing the ability for citizens to download forms (Layne and Lee, 2001). Communication at this stage is one-way: from government to citizens (G2C) (Basu, 2004).
4. The fourth stage is more **dynamic and interactive**. Phone services or the internet are available for citizens to obtain clarity about issues, submit documentation, or schedule a service (Cloete, 2012). The simple applications that would normally only have been possible at a counter during office hours are available online 24 hours per day (Basu, 2004). Communication is two-way: between government and citizens, businesses and/or NGOs.
5. The fifth stage is the stage at which **electronic transactions** are facilitated. Payments are possible and documents can be received electronically (Cloete, 2012). Security and personalisation issues increase complexity (Basu, 2004). Digital signatures become necessary to enable legal transactions (see e.g. Brown, 1993).
6. The sixth and final stage is the **transformation stage.** Here "e-government outputs are transformed into e-governance outcomes in that public services and governance transactions are exclusively electronically mediated" (Cloete, 2012, p. 129). The external and internal objectives of e-government (Basu, 2004) are met in the transformation stage. In its fullest extent, transformation could include societal transformation as well as government transformation through fully functional citizen feedback into government processes.

Prathab and Girish (2006) give the following definition and description of ***e-governance***: "It is the use of a range of modern [ICTs] … by government to improve the effectiveness [and] efficiency [of] service delivery and to promote democracy." The focus of e-governance is on greater attention to improving the service delivery mechanism, enhancing the efficiency of production, and emphasising wider access to information. e-Governance is understood to include the functions of e-government, e-regulation, and e-democracy (Finger and Pécoud, 2003). E-governance can be distinguished from e-government in that the latter is institutional and procedural whereas the former refers to the entire system of electronic government and its internal and external interactions (the act of governing), the end result of which is understood to be e-democracy. Whittal asserts that "e-governance is about the use of [ICT] as a tool to reform government processes and to achieve broad societal goals" (Whittal, 2011, p. 172).

In the field of cadastral systems, Cloete's (2012, p. 129) "e-governance outcomes" are understood to include the achievement of the principles of good governance. A well-designed and fully-functioning e-cadastral system should facilitate multi-level (G2G) as well as multi-path (G2C, C2G, G2B, B2G, etc.) interactions (stages 3 and 4). Electronic transactions in land rights and supporting documentation should be facilitated (stage 5). Lastly, an e-cadastral system should promote on-going transformation of the relationship between people and the land (land tenure) and the government systems that reflect these relationships (stage 6).

5. Conceptions of Future Cadastral Systems

Jones and Land (2012) argue that a fresh approach to cadastral systems is needed if such systems are to be described as well-functioning. A well-functioning cadastre is essential for securing rights in property and land, for wealth creation, and for better environmental management. Yet few cadastral systems around the world can be described as well-functioning due to institutional inertia, inadequate/inappropriate legislation, poor leadership and badly designed land administration systems (*ibid*.). An e-cadastral system that achieves e-governance outcomes has the potential to be a well-functioning cadastral system.

Conceptions of future cadastral systems have been proposed in several significant conceptual developments (Bennett *et al*., 2010): the FIG Statement on the Cadastre (FIG, 1995), the Bogor (FIG, 1996) and Bathurst (UN-FIG, 1999) Declarations, Cadastre 2014 (Kaufmann and Steudler, 1998), the Land Management Paradigm (Enemark, 2005), the Core Cadastral Domain Model (CCDM) (van Oosterom *et al*., 2006), the STDM (Augustinus, 2010), and the LADM (Lemmen, 2012) among others. Expectations for future cadastral systems are proposed by Bennett *et al*. (2010) and Jones and Land (2012), while Uitermark *et al*. (2010) have proposed a vision for a spatially enabled society in 2025. Drawing on these and other sources, four concepts of ideal future cadastral systems are identified, as described below.

5.1 Accommodating

The beneficiaries of e-cadastral systems implementation should not only be limited to those enjoying the formal cadastre, but should be extended to **recognise multiple forms of tenure**: a continuum of rights (Jones and Land, 2012; Sietchiping *et al*., 2012; UN-HABITAT, 2008; Zevenbergen *et al*., 2013) such as are in existence in developing nations like South Africa (Cousins and Hornby, 2006). In this way security of tenure can be provided for all (UN-FIG, 1999) and diversity is recognised (FIG, 1996). By linking the cadastral information system to the STDM, formal and informal land markets could be managed in one LIS that accommodates all of the tenure arrangements in a particular country (Augustinus, 2010).

The cadastral system of the future should also be **multi-purpose**: meeting a "range of needs beyond simply recording land ownership or defining parcels for taxation" (Jones and Land, 2012, p. 2). The shift in focus towards the multipurpose cadastre has come about since the 1980s in response to the global concerns of environmental degradation, urbanisation, natural disasters, climate change, poverty, sustainable development, and social equity (Bennett *et al*., 2010; Jones and Land, 2012; Riecken and Seifert, 2012) among others.

A well-designed e-cadastral system should be able to accommodate multiple forms of tenure for multiple purposes.

5.2 Allow for real-time data improvement and verification

The desire for the cadastral system of the future is that the cadastre can be updated, verified and accessed on-the-fly, i.e. as surveyors create or change a land parcel in the field, the cadastral database is updated to reflect these changes (Bennett *et al*., 2010; Jones and Land, 2012). Hence the

cadastre will always be up-to-date and will reflect the situation on the ground as it evolves. Uitermark *et al*. (2010) envisage a system wherein parcel boundaries can be updated by non-professionals using web-services validated by land administrators.

5.3 Survey-accurate (including heights and time)

There should be no ambiguity surrounding the locations of property boundaries within the e-cadastral system and these boundaries should be defined using the highest possible standards of accuracy (Bennett *et al*., 2010) as laid down by the relevant land policy (Enemark, 2005). But until this is realised, the level of accuracy in the system should be fit-for-purpose (Enemark, 2012). In this regard, proponents of the LADM argue for a continuum of accuracy: spatial units may be represented as textual descriptions, points, lines, polygons, or polyhedrons as appropriate (Lemmen *et al.*, 2013b).

The need for the inclusion of heights in the cadastre is proposed by Bennett *et al*. (2010), Jones and Land (2012) and Riecken and Seifert (2012) with reference to the need to keep up with the challenges posed by rapid urbanisation and climate change (especially sea level rise). (See also Stoter, 2004.) Eventually this will be extended to include time as well (Uitermark *et al*., 2010).

5.4 Provide a secure foundation for a nation's SDI and land administration

Cadastral information forms the core of a **Spatial Data Infrastructure** (SDI) (Borzacchiello and Craglia, 2012; Jones and Land, 2012; Rajabifard *et al*., 2007; Riecken and Seifert, 2012). SDI provides the framework within which land and geographic information can be shared. The cadastral parcel, as a foundational layer of the SDI, allows decisions to be related to stakeholders in a property, along with the property features (*ibid*.). This implies that the cadastre and land registry should be unified for ease of access and management of land information (Kaufmann and Steudler, 1998; Uitermark *et al*., 2010).

6. Defining e-Cadastral Systems

The preceding discussion paves the way for the definition of an e-cadastral system. It draws on the principles of good governance, e-governance, and aspires to the ideals of future cadastral systems. It is noted that, just as the term cadastral system is an extension of the term cadastre, so the e-cadastral system includes the political, legislative, economic, technological, and social aspects and relationships of e-cadastres, especially if stage 6 of e-governance is to be realised. Following systems theory, the properties of the e-cadastral system (the whole) is more than the sum of its parts. From this exploration, the following definition of an e-cadastral system is proposed (see Figure 1):

> *An e-cadastral system is an electronic, parcel-based LTIS that combines the roles of the agencies in control of surveys and mapping, land registration, land valuation and land use / development in a manner that aims to broadly satisfy e-governance outcomes as related to cadastral systems development.*

The parcel referred to above is defined in Section 2. This implies that any spatial unit of area / volume can be included in an appropriately designed e-cadastral system. These may include "thematic polygons of low accuracy" showing approximate boundaries of informal or customary settlement areas (Augustinus *et al*., 2006, p. 17). If the system is to be truly accommodating, it cannot use the traditionally defined cadastral parcel as its basis (Augustinus, 2010). But, with reference to Silva and Stubkjær (2002), the e-cadastral system must be spatially referenced, hence it is parcel-based.

In combining the roles of surveys and mapping, land registration, land valuation, and land use / development, the e-cadastral system is closely associated with e-land administration as defined in Section 2. The concepts of good governance and the land parcel identified in the cadastre form the basis for land administration (Enemark, 2012; Whittal, 2011; Williamson *et al*., 2010). Hence e-cadastral systems form a subset of e-land administration (which includes institutions, processes, communication and accountability) and should feed into and support the overall goal of improving services to citizens through good (e-)governance. As such e-cadastral systems are designed to meet the following non-concurrent goals:

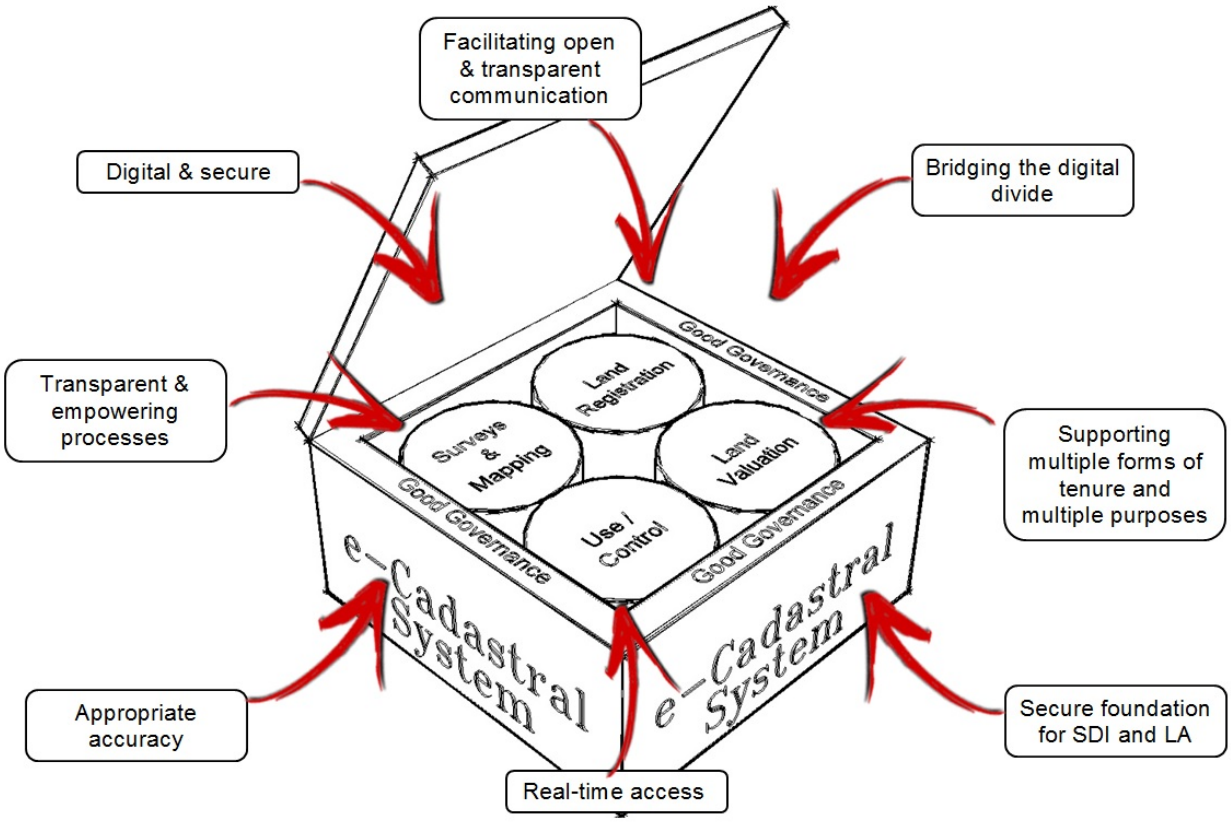

Figure 1 The e-cadastral system

1. **Fully digital records** and processes are **securely stored** and appropriately backed up, yet paper-based records are still available on demand for stakeholders who do not have appropriate

electronic access. The land policy should guarantee the security of the cadastral data with attention to electronic signatures, digital copies, copyrights, and liabilities.

2. Facilitates **open and transparent communication** between all stakeholders (including government, business, NGO and citizens) at multiple levels and in multiple ways in an accessible, clear and simple manner. This means that stakeholders can access information related to their interests in a 'baunit' (Lemmen *et al.*, 2013a) and check the relevant details as e.g. an application is examined by the local authority. It also means that G2G communication should follow a **uniform standard** (see e.g. Tjia and Coetzee, 2013).
3. Inclusivity in that it:
   a) is designed to **bridge the 'digital divide'** and the variable accessibility of resources that is characteristic of many developing and developed countries (Servon, 2008). Apart from variable accessibility, it should also seek to make advanced systems of interaction available to the poor, such as through public terminals/workstations;
   b) **recognises multiple forms of land tenure** and reflects the full spectrum of land rights from informal to formal, including a variety of land transactions appropriate to these levels, as described in the STDM;
   c) is designed to meet the diverse needs of a range of stakeholders such as owners, developers, government institutions, interested and affected parties, beneficiaries of government housing programmes, *etc*. (**multipurpose**).
4. Delivers a **complete and up-to-date record** of all land rights, restrictions and responsibilities (formal, informal and customary) thus providing a **secure foundation** for a nation's SDI and land administration.
5. **Real-time access** to land parcel information for efficient and effective updating (redefining) by certified professionals (e-surveying and e-conveyancing) on-the-fly. The system must also be accessible for transacting and querying by relevant stakeholders.
6. **Appropriate accuracy** for the level of land tenure and land right (e.g. survey-accurate for properties with a high market value in urban areas and lesser accuracy for others), including heights where possible / desirable.
7. **All processes are transparent and empowering**, allowing for civic engagement with government on any cadastral issue (e.g. objections to developments) or issue of e-cadastral system design or operation. The system should accommodate those without reliable / convenient electronic access by providing suitable alternatives.

7. Conclusion

This paper has explored the concepts that feed into a better understanding of the terms e-cadastre and, principally, e-cadastral system, which are in general use. Elements from good governance, concepts of future cadastral development, and an understanding of e-government and e-governance have fed into the proposed working definition of an e-cadastral system.

The stated purpose of this paper is to propose a definition of e-cadastral systems based on the prevailing relevant literature as a precursor to the development of critical theory in LTIS. This was

motivated by the dearth of critically developed and tested theory in LTIS and the need for clarity and consensus of terms used. The argument for standardisation of terms is supported by the authors as a means of fostering good governance and promoting sustainable development.

It is hoped that this discourse will stimulate critique and further development of the concepts of e-cadastral systems such that formal critique of these systems will be possible in the future. In this regard it now remains for this definition to be subjected to rigorous testing through practical and theoretical use.

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