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Editorial

Cadastral systems III

The first (double) and second special issue on 'Cadastral Systems' and a special issue on 3D Cadastres in *Computers, Environment and Urban Systems* (CEUS) (Lemmen & van Oosterom, 2001, 2002, 2003a) underlined the relevance and interest of scientific, peer reviewed, publications in developments in cadastral systems, e.g. business context, legal and institutional framework, information management, data- and process-modelling, technical aspects, and business alignments to new information and communication technologies (ICTs). As noted in earlier editorials one of the problems related to publications in the Cadastral domain is the lack of a shared set of concepts and terminology, which makes the reviewing task quite difficult. International standardisation of these concepts (that is, the development of an ontology) could resolve many of these communication problems. With this in mind, we begin this editorial with an overview of current standardisation efforts, with specific focus on the role of the FIG (International Federation of Surveyors) in Section 1. As we will see later on, there are often other motivations behind these standardisation efforts, such as meaningful exchange of information between organizations, or efficient component based system development through applying standardised models. Section 2 of this editorial then provides an overview of the papers in this special issue.

1. Standardisation of the cadastral domain

It should be repeated that a cadastral system entails land registration, the 'administrative/legal component', and cadastral mapping, the 'spatial component'. Together, these components facilitate land administration and a cadastral system provides the environment in which this process takes place. Data are maintained and disseminated in a distributed environment, which in principle means that data could be maintained by different organisations, such as municipalities or other planning authorities, private surveyors, conveyancors and land registrars—depending on the local traditions. Standardisation of the Cadastral Domain is in the initial phase and many non-co-ordinated initiatives can be identified. FIG Commission 7, 'Cadastre and Land Management', undertakes coordination efforts in this context.

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Standardisation of the Cadastral Domain is relevant because computerised cadastral systems can support a customer and market driven organisation with changing demands and requirements. Customers want to have an efficient on line information service that links to the data base(s) of cadastral organisations. The application software to support cadastral processes is extending continuously in many countries because of changing requirements. In the future the volume of cross border information exchanges are expected to increase, particularly within the European Union. The more remote that the data user is from the data source, the more important it becomes to ensure that the data are well defined—for the obvious reason that remote users are likely to have much reduced local knowledge to assist them in interpretation. Trying to make the meaning of the data explicit is therefore an important step in facilitating meaningful exchanges of information across greater distances. The concepts used have to be well defined and structured (that is, related to one other), and this entails development of a cadastral domain ontology. One potential way to express parts of this ontology is UML (Unified Modelling Language) class diagrams.

Cadastral data that are accessible in a computerised environment can (significantly) increase the demand for cadastral data in the cadastral market. Standardisation contributes to efficient development and renewal of cadastral systems. Many land registry or cadastre organisations implemented their computerised systems between 10 and 20 years ago. These systems are now outdated, and their maintenance is complex and expensive. The organisations are now increasingly confronted with rapid developments in the technology: there is a *technology push* driven by developments in the Internet, (geo)-databases, modelling standards, open systems, GIS; and a *market pull* driven by increasing demand for enhanced user requirements, e-governance, sustainable development, electronic conveyancing, and integration of public data and systems. A great deal of effort is being devoted to the development of viable strategies for the modernisation of the ICT systems of Land Registry and Cadastre organisations. Standardisation in the cadastral domain would help (geo-) ICT vendors, as it would allow them to invest their efforts in the development of a (generic) system, based on the concepts as described in UML class diagrams, instead of focussing on a single cadastral organisation. This would stimulate the availability of generic (object-oriented) standard software from multiple (geo-)ICT vendors from which the cadastral organisations can make a selection. This will provide them with the fundament of new systems (in ways that are largely compatible with the concepts used in other countries), without developing everything from scratch: only local modification and extensions would need to be developed.

The idea for the introduction of a Core Cadastral Domain Model was launched at the FIG Congress in Washington April 2002 (van Oosterom & Lemmen, 2002). During this meeting there was a great deal of attention for the issue of standardisation: the FIG guide on standardisation was presented and it was decided to continue the work of the FIG Task Force on Standardisation in the 'FIG Standards Network'. Standardisation has also been one of the main themes of interest for the FIG Working Week in Paris April 2003 see for example Lemmen and van Oosterom (2003b).

It may be observed that considerable efforts are being made to attain standardisation in the cadastral domain. In Germany, the Working Committee of the Surveyors Authorities of the States of the Federal Republic of Germany (AdV) has begun developing a new conceptual data model for the Official Cadastral Information System (ATKIS) based on ISO TC211 standards (Seifert, 2002). The Cadastral Subcommittee of the US Federal Geographic Data Committee has developed a complete Cadastral Data Content Standard for the National Spatial Data Infrastructure (ICSM, 1999). The US National Integrated Land System (NILS) provides business solutions for the management of cadastral records and land parcels information in a Geographic Information System environment (von Meyer, Oppmann, Grisé, & Hewitt, 2001). In New Zealand the new Cadastral Survey Exchange Format, as part of the Land *online* survey and title automation programme, is based on the LandXML (2002) (see also LINZ, 2002). The European market is becoming more integrated. So far, property transactions have remained fairly nationally delineated and complaints have been made about the lack of a single mortgage market. In order to speed up the integration process, Landmäteriet Sweden has initiated a project for providing the market with a single point of access to land information across the borders: the EULIS project (Ollén, 2002). The INSPIRE-initiative [1] of the EU is "an initiative to support the availability of spatial information for the formulation, implementation and evaluation of Union policies". In total, 60 spatial data components, grouped around 17 themes have been identified as important data-sets, including topography, cadastral properties, the geographical names of administrative areas, postcodes, buildings and addresses, terrain elevation and ortho-photos. INSPIRE 'intends to set the legal framework for the gradual creation of a spatial information infrastructure'. INSPIRE can be considered as an important outcome of the 6th Environmental Action Program (2001–2010) of the EU. One of the starting-points of this program is 'to ensure better and more accessible information on the environment for citizens'. [2]

The introduction of a simple, generic Core Cadastral Domain Model could encourage and support the flow of information relating to land property between different government agencies and between these agencies and the public. Whilst access to data, its collection, custody and updating should be facilitated at a local level, the overall land information infrastructure should be recognised as belonging to a uniform national service so as to promote sharing within and between nations. A Core Cadastral Domain Model in which classes and associations between classes representing objects, attributes and operations are derived from different tenure systems could, in the opinion of the authors, definitively contribute to the efficient fulfilment of local cadastral needs.

The guest editors propose the development of a standardised core cadastral data model based on the geographic standards from ISO TC211 and OpenGIS (Lemmen et al., 2003; van Oosterom & Lemmen, 2002, 2003). This cadastral model will be developed in co-operation with the FIG; the research is related to the framework of

[1] http://www.ec-gis.org/inspire

[2] http://europa.eu.int/comm/environment/newprg/index.htm

the COST (Co-ordination in the field of Scientific and Technical Research) Action G9: 'Modelling Real Property Transactions' (Stubkjær, 2002). The Open GIS Consortium is developing a Property and Land Initiative as announced in a press release of March 25, 2003. The item of standardisation was the key issue of a Workshop on Cadastral Data Modelling organised by ESRI and ITC, in Enschede, The Netherlands, March 17 and 18, 2003. The basis for the discussions was the 'Cadastre 2014 Model' (Kaufmann & Steudler, 1998) and a draft cadastral model developed by Delft University of Technology and ITC. The main outcomes of the discussions were recommendations that the approach should be fully object oriented, a core spatial model of (public) restrictions should be included, maintenance of historical data should be supported, the model should be presented in full accordance with UML standards, there should be the flexibility to include only those data that will be maintained, all object classes and attributes should be identified and described, and that model implementation should be driven through publication and updating of land transactions. Fig. 1 (Lemmen et al., 2003) gives an impression of the model in which some recommendations of the workshop are included: green is the real core, green and yellow cover the legal/administrative aspects, green and blue are real estate object specialisations (including 3D aspects), and blue, pink and purple are related to surveying/geometrical/topological aspects.

To summarise, a standardised core cadastral domain model will serve at least two important goals: it will avoid reinventing and re-implementing the same functionality over and over again, but will provide a extensible basis for efficient and effective cadastral system development, *and* will enable stakeholders, both within one country and between different countries, to engage in meaningful communication based on the shared ontology implied by the model.

2. Overview of the accepted papers

The accepted papers in this special issue cover a broad range of subjects: from marine cadastres, to cadastral technical and documentation subjects, and to information systems and implementations in developing countries.

Worldwide more and more attention can be recognised to the development and implementation of marine cadastres because of their relevance to environmental concerns, natural resource exploitation and public and private rights to marine space. In the paper by *Sam Ng'ang'a*, *Michael Sutherland*, *Sara Cockburn* and *Sue Nichols* (University of New Brunswick, Canada) a review of technical framework requirements is presented for a 3D Marine Cadastre. The paper highlights the value of the marine cadastre and its information on property rights in providing support for decision making associated with good ocean government and gives an outline for a technical framework to build a marine property rights information infrastructure. The paper concludes by outlining other issues that need to be considered in developing a marine cadastre.

The conduct of transactions using a cadastre is the subject of the paper by *Gerhard Navratil* and *Andrew Frank* (University of Vienna, Austria). Transaction pro-

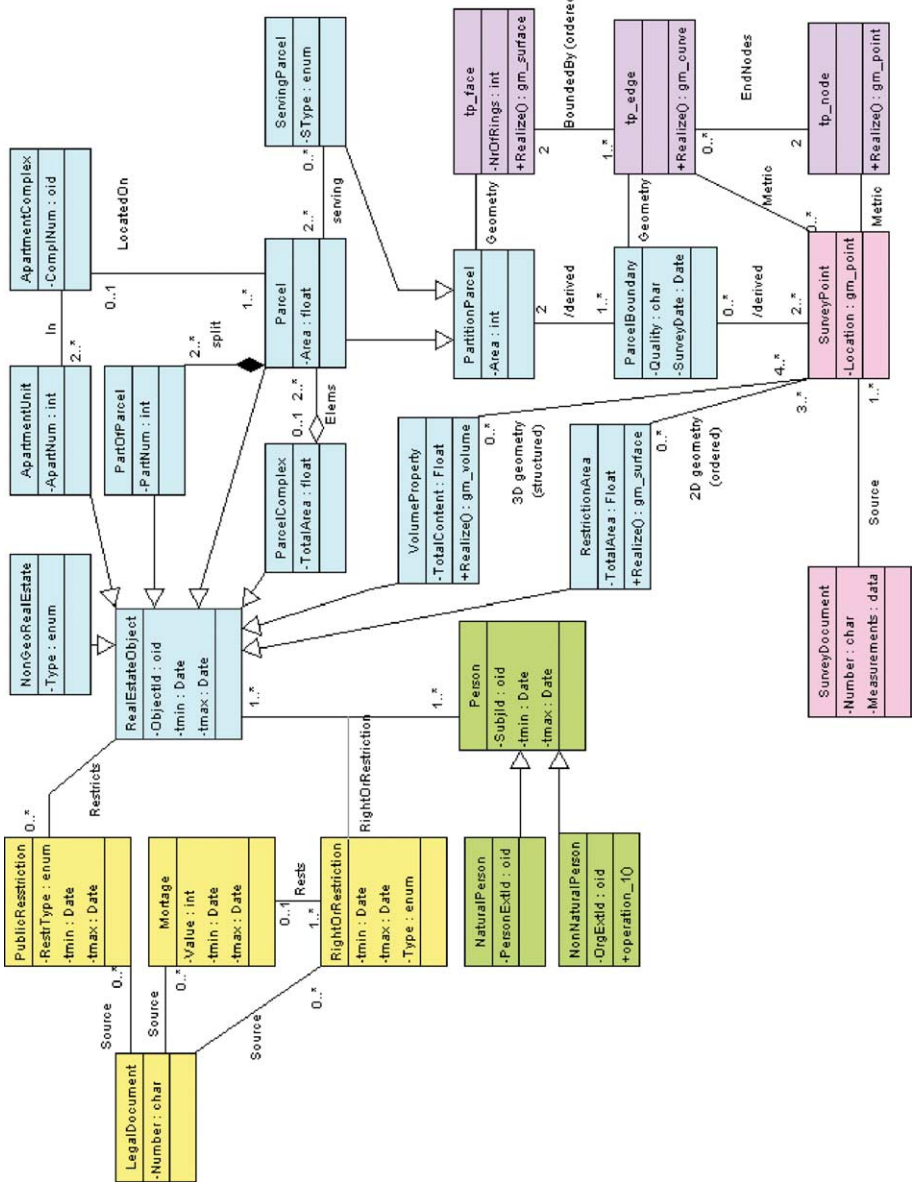

Fig. 1. The Core Cadastral Domain Model.

cesses are based on input documents and require human interaction, yet computerised data retrieval is possible where all document data are included in a digital cadastre. Their paper presents a formalised approach to representation of these processes using an object oriented programming language in relation to databases for Austria and the United States. Their starting point is the needs of users: owners, government and many others.

Ally Peerbocus and *Geneviève Jomier* (University of Paris Dauphine, France) highlight some issues arising out of the inclusion of historical cadastral data in computerised cadastral systems. The documented spatiotemporal Maps Approach, based on a multi-version database, supports representation of the history of lots and parcels. This provides one more step in the development to completely digital cadastral systems; at present a substantial amount of this type of information is still paper or microfiche based, e.g. field sketches, deed- and title documents etc., and is held at cadastre or conveyancor offices or at citizens houses. A prototype has been developed based on a case study using the French cadastre. Various advantages of this approach are presented.

The next paper by *Daniel Karnes* (Dartmouth College, United States) is also on a typical cadastral subject: updating location in a cadastral spatial database. Terrestrial observations based on modern survey technology provide accurate co-ordinates. One requirement in the approach presented here is that in updating the cadastral database these more accurate surveys are entered before less accurate ones are accommodated around them. A prototype of an application is presented to address this problem, based on a strategy that allows updating of location in date-forward order. The general framework presented—for capturing locational procedure, reference objects, and measurement values for individual entities in a map (spatial database) and allowing their update in a date forward fashion—could have application in other areas of geographic information science.

The last two papers focus on the complexities and difficulties of implementing and maintaining cadastre and land administration in developing countries. In the first paper, by *Walter de Vries* (International Institute for Geo-Information Science and Earth Observation—ITC, The Netherlands), a review of progressive land titling is presented, in relation to new surveying practises, land administration procedures and associated land information systems. The impact of both upgradeable regimes of rights to land and a stepwise system of land surveying on land information systems is highlighted and worked out into a conceptual relational diagram. It is concluded that an integrated model of performance, linking performance of societal interventions (such as progressive titling) to performance of changes in technical tools and regulations is necessary. Part of this model should be an alternative concept of land information systems.

The second paper with a focus on developing countries by *Mikka-Petteri Törhönen* (FM-International Oy Finnmap, Finland) concerns sustainable land tenure and land registration in developing countries, and a comparison to the (recent) past of an industrialised country. The results of four case studies—three in developing countries (Cambodia, Zanzibar and Zimbabwe) and one in an industrialised country (Finland)—are integrated into a basic framework. The framework presents

an interpretation of *key issues* underpinning sustainable land tenure and land registration. Good governance, sensible and culturally sensitive resource use, equity, quality and commitment are requirements for the development and maintenance of effective land administration at national level. Sustainable development is seen as best promoted through secure, flexible, all-inclusive land tenure, although alternatives are identified in case those requirements do not apply. This paper is of value to developing countries where implementation of (computerised) cadastral and land administration systems are under consideration: it recognises that an ambiguous, ineffective land administration that disenfranchises a large part of the population and provides insecure tenure is a dangerous institution.

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