PREFACE

In the past decade various activities have been conducted related to 3D Cadastres. The start of the international awareness of this topic was marked by the 1st International Workshop on 3D Cadastres. This first workshop was organized by Delft University of Technology in November 2001 and fitted within work plans of the International Federation of Surveyors (FIG) commissions 3 'Spatial Information Management' and 7 'Cadastre and Land Management'. This was followed by virtually a session at every FIG Working Week and Congress afterwards. The 2nd International Workshop on 3D Cadastre is now organized as joint activity of the FIG (again commissions 3 and 7), the European Spatial Data Research Organization (EuroSDR) and Delft University of Technology.

During the past decade the on-going developments at cadastral organizations in many countries did provide better 3D-support. The increasing complexity of infrastructures and densely built-up areas requires a proper registration of the legal status (private and public), which only can be provided to a limited extent by the existing 2D cadastral registrations. Despite all research and progress in practice, no country in the world has a true 3D cadastre, the functionality is always limited in some manner; e.g. only registering of volumetric parcels in the public registers, but not included in a 3D cadastral map, or limited to a specific type of object with ad hoc semi-3D solutions; e.g. for buildings or infrastructure. At the FIG Congress in April 2010 in Sydney it was decided to form again a working group on 3D cadastres in order to make further progress. The registration of the legal status in complex 3D situations is investigated under the header of 3D cadastres. Starting point of the 3D Cadastres Working Group 2010-2014 is the observation that increasingly information is required on rights, use and value in complex spatial and/or legal situations. The main objective of the working group is to establish an operational framework for 3D Cadastres. The operational aspect addresses the following issues:

1. A common understanding of the terms and issues involved. After the initial misunderstandings (due to lacking shared concepts and terminology) in the early days, the concepts should now be further refined and agreed on, based on the ISO 19152 Land Administration Domain Model (LADM), which provides support for 3D representations.
2. A description of issues that have to be considered (and to what level) before whatever form of 3D cadastres can be implemented. One could think of a checklist for the implementation of 3D cadastres. These will provide 'best practices' for the legal, institutional and technical aspects. These findings will be translated in basic guidelines for the implementation of 3D cadastres.

The main purpose of this workshop is to have a fruitful exchange of ideas. There does not exist a single best solution for a 3D cadastre. In all cases for the establishment of such a cadastre, legal, institutional and technical issues have to be addressed. The level of sophistication of each 3D cadastre will in the end be based on the user needs, land market requirements, legal framework, and technical possibilities. Therefore, in line with the ISO 19152 Land Administration Domain Model (LADM) it is the intention to explore the optimal trade-offs between 2D en 3D cadastral solutions. It is also imperative to address the issues that arise in the transition zones between 2D and 3D representations. The concept of 3D cadastres with 3D parcels is intended in the broadest possible sense. 3D parcels include land

and water spaces, both above and below surface. However, what exactly is (or could be) a 3D parcel is dependent on the legal and organizational context in the specific country (state, province). For example, in one country a 3D parcel related to an apartment unit is associated with an ownership right, while in another country the government may be owner of the whole apartment complex and the same apartment unit is related to a use right. In both cases there are explicit 3D parcels, but with different rights attached. A third country may decide not to represent the apartment units with explicit 3D geometries at all (and the 3D aspect is then 'just' conceptual). A more formal definition: A 3D parcel is defined as the spatial unit against which (one or more) unique and homogeneous rights (e.g. ownership right or land use right), responsibilities or restrictions (RRRs) are associated to the whole entity, as included in a land administration system. Homogeneous means that the same combination of rights equally apply within the whole 3D spatial unit. Unique means that this is the largest spatial unit for which this is true. Making the unit any larger would result in the combination of rights not being homogenous. Making the unit smaller would result in at least 2 neighbour 3D parcels with the same combinations of rights.

There are several 3D cadastre scoping options, which need to be investigated in more detail, and the result will define the scope of the future 3D cadastre in a specific country:

1. What are the types of 3D cadastral objects that need to be registered? Are these always related to (future) constructions (buildings, pipelines, tunnels, etc.) as in Norway and Sweden or could it be any part of the 3D space, both airspace or in the subsurface as in Queensland, Australia?
2. In case of (subsurface) infrastructure objects, such as long tunnels (for roads, metro, train), pipelines, cables: should these be divided based on the surface parcels (as in Queensland, Australia) or treated as one cadastral object (as in Sweden)? In case of subdivision, note that to all parts rights (and parties) should be associated.
3. For the representation (and initial registration) of a 3D cadastral object, is the legal space specified by its own coordinates in a shared reference system (as is the practice for 2D in most countries) or is it specified by referencing existing topographic objects/boundaries (as in the 'British' style of a cadastre)?

Note that there can be a difference between the 3D ownership space and the 3D restriction space; e.g. one can be owner up to ±100 m around the earth surface, but only allowed to build from -10 to +40 m. Both result in 3D parcels, that is, 3D spatial units with RRRs attached. The ownership spaces (parcels) should not overlap other ownership parcels, but they are allowed to overlap other space; e.g. restriction parcels.

The organization of this workshop was supported by the Open Geospatial Consortium (OGC), the International Society for Photogrammetry and Remote Sensing (ISPRS) and Geo-informatie Nederland (GIN) via endorsing the workshop within their communities. The sponsors, Oracle, Bentley, ESRI, Kadaster and the Netherlands Geodetic Commission, part of the Royal Netherlands Academy of Arts and Sciences (NCG-KNAW) are gratefully acknowledged for their financial contributions, lowering the threshold for other participants, but in many cases also for their content wise contribution in the form of a paper in the proceedings and presentation at the workshop. The call for workshop contributions included the following list of relevant topics:

- Analysis of 3D use cases
- 3D legal objects and physical objects

- Building units (apartments) as 3D parcels
- 3D constructions as 3D parcels
- Utility networks as 3D parcels
- Airspace or subsurface space 3D parcels
- Potentially unbounded 3D parcels (towards the sky)
- Natural resources (groundwater, mining) as 3D parcels
- Polluted areas as 3D parcels
- Spatial (zoning) plans as 3D parcels
- Legal framework for 3D cadastre
- Range of RRR (Rights, Restrictions, Responsibilities) attached to 3D parcels
- 3D data acquisition (survey plans)
- Initial registration of 3D parcels
- 3D data management
- 3D cadastres and models
- Relationship 2D and 3D parcels
- Height representation: absolute/relative
- 3D geometry and topology
- 3D cadastres and time
- Implementation in a cadastral database
- Visualization, distribution and delivery of 3D parcels
- 3D exchange formats
- Web-based access to 3D parcels
- 3D cadastres and Spatial Information Infrastructure
- 3D cadastres and usability

In total the call for contributions resulted in 38 abstract submissions indeed covering most of the mentioned topics above. Each abstract was typically reviewed by 3 or 4 PC-members. Based on the (very) good review scores, 32 contributions were selected and their authors did submit a full paper to the workshop. These are all included in the proceedings, both on paper (in black and white) and on-line http://3dcadastres2011.nl (with colour). The workshop has two types of sessions: a. plenary presentation and discussion sessions (typically 20 minutes presentation and 10 minutes discussion per contribution) and b. parallel working sessions (2 times 90 minutes sessions in four groups: 1. Legal framework 3D cadastres, 2. Initial registration of 3D parcels, 3. 3D data management, and 4. Visualization, distribution and delivery of 3D parcels). In total there are 30 contributions in the plenary sessions and there are 2 late contributions in the parallel working sessions.

The Programme Committee members are acknowledged for their diligent work in assessing the quality of the abstracts. Many of their suggestions have been used by the authors in the full paper versions. Further, authors that submitted an abstract and authors that will present their full paper at workshop are providing the real workshop content and are gratefully acknowledged. The chairs of the four working sessions, Hendrik Ploeger, Rod Thompson André Streilein, and Jacynthe Pouliot, are thanked for their efforts in preparing the discussions in the form of their position papers and willingness to chair the working sessions during the workshop (see page 543 and onwards of these proceedings). Finally, many thanks to Itziar Lasa Epelde for the graphic designs (of the workshop flyer, poster and cover of book), Christel Swarttouw-Hofmeijer for the workshop administration (registration), Theo Tijssen (creating and maintaining the digital environment: both the website for the 3D

Cadastres workshop, available at http://3dcadastres2011.nl/ and the website for the FIG joint commission 3 and 7 Working Group on 3D Cadastres, available at http://www.gdmc.nl/3DCadastres/) and my other fellow colleagues from the local Organizing Committee.

I do wish all participants a very fruitful and pleasant workshop!

Delft, November 2011,

Peter van Oosterom/Chairman.