# 3D Property Research – a Survey of the Occurrence of Legal Topics in Publications

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**Key words**: Classification, Legislation, Terminology, 3D Property, 3D Cadastre

## SUMMARY

3D property is an increasingly discussed and researched topic. Several conferences and workshops have contained contributions on this subject and there are often special sessions devoted to it at e.g. FIG conferences. There are also many articles, conference contributions, theses and other publications available that present and discuss 3D property from different aspects. However, many of these conferences and publications seem to focus on technical aspects of 3D property rather than on legal aspects. It even seems that more is written on technical issues and registration than on other equally important issues related to law, organisation, etc. which creates a certain imbalance within the field.

The aim of this paper is to investigate the field of 3D property in research, as evidenced by conference papers and other publications, in order to find the distribution of areas of interest and specifically the occurrence of legal aspects. The intention is not to describe any particular 3D property issues or to present a complete survey, but to analyse trends within the field and to contribute to the methodology and structure of 3D research.

A case-study was conducted by examining conference papers, journal articles and other publications in English on 3D property within the recent ten year period. The studied publications were placed in four different groups, illustrating different aspects of 3D property, namely legal, technical, registration and organisational issues. The classification was done after analysing the publications by their contents. The total number of studied publications is 105. The results indicate a rather even distribution between three of the four categories, except for organisational aspects, which are in minority. However, when looking from a legal perspective, the legal category is in minority with only 28 publications, in comparison with the total number of the publications in the other three categories, consisting of 77 publications.

Thus, although there already exists a foundation of results from research and other works on the legal aspects of 3D property, the authors believe that more work is needed and that more and focused attention should be given to legal aspects of 3D property.

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## 1. INTRODUCTION

### 1.1 Background

3D property is an increasingly discussed and researched topic. Several conferences and workshops have contained contributions on this subject and there are often special sessions devoted to it.[1] Due to this there are a number of academic articles, theses and other publications that present and discuss 3D property from different aspects; legal, registration, technical, organisational, etc. 3D property research covers a range of topics from legal issues to data visualisation.

It seems to the authors that many publications in the field of 3D property focus on technical/data registration aspects, whereas the legal aspects have been less researched. There are, however, some tendencies that the interest in the legal aspects is increasing. An example is the development of the coming international standard for land administration, ISO 19152 – Land Administration Domain Model (LADM) (ISO 2011). The LADM in its present state is focusing on the legal aspects of land administration, whereas the model used as basis for the LADM, the Cadastral Core Domain Model (van Oosterom et al 2006) seems to be more focused on geometrical aspects of land administration, so a shift towards a legal focus has taken place.

The tendency is also illustrated by holding a separate legal section on 3D property at the current second international workshop on 3D cadastre in Delft, the Netherlands (hereafter referred to as the second 3D Delft workshop 2011). However, the authors of this paper have not found any research or discussions about the nature and content of 3D property research conducted in the last decade.

### 1.2 Problem description

This paper is partly based on and continues the discussion on terminological aspects on 3D property in Paasch and Paulsson (2011), where it is concluded that we find different terminology for 3D property, which to a great extent depends on the national terminology used in legislation, but that many encountered definitions are technical, not legal in nature. Furthermore, it was also noted that there is a lack of a clear, main terminology for the general concept regarding 3D property which makes it difficult to standardize what is meant with "3D cadastre". This makes it challenging to determine what publications on this topic are really about, and what aspects of 3D property they deal with, since the terminology is not used consistently throughout the domain.

[1] See the 3D cadastre reference list on the second 3D cadastre 2011 workshop website: http://www.gdmc.nl/3DCadastres/

Furthermore, terminology is fundamental for searching and discovering of data. If e.g. keywords are not standardized or too general, it is difficult to locate, evaluate or interchange information. A pragmatic example is that a non-standardized terminology makes it difficult to determine the detailed subject on publications on a specific topic, e.g. the implementation of 3D property legislation.

It can also be noticed that authors from different countries, and sometimes even authors within the same country, use different terminology when describing 3D property, especially when writing in a non-native language, such as English.

### 1.3 Aim

The aim of this paper is to investigate the field of 3D property in research, as evidenced by conference papers and other publications written in English, in order to find the distribution of areas of interest and specifically the occurrence of legal aspects. The intention is to analyse trends within the field and to contribute to 3D property research.

### 1.4 Hypothesis

Previous research within the field of 3D property has shown a tendency towards increased focus in research and publications on technical and registration aspects rather than on issues related to law and organisation, etc., which creates a certain imbalance within the field. The hypothesis is thus that non-legal aspects of 3D property are more researched than the legal aspects.

### 1.5 Method and delimitation

The authors have chosen to conduct a case study to survey the topics researched in 3D property publications. When starting the study the first question was which publications to include. It was chosen on the basis of the authors' a priori experience in the field of 3D property to delimit the case-study to the decade between the first international 3D conference/workshop in Delft in 2001 to the second workshop in Delft in 2011. The first conference in Delft is by the authors regarded as a "starting point" for this type of more organized activities within 3D property research. The sampling was further delimited by only studying publications listed on the 3D cadastre reference list at the second 3D Delft workshop 2011 website[2], in addition to the presentations from the Nordic 3D real property conference in Stockholm, Sweden, in 2010 (presently in the publishing/peer-review process). The decision not to include other 3D publications is strictly due to time limitations. Furthermore, only publications written in English have been considered due to language limitations. Publications on legal concepts are mainly of national interest and therefore not always intended for an international audience, but written in a national language. Technical issues are more often international and therefore often written in English. Publications describing national legal 3D property issues are therefore most likely to be written in national languages. They are not part of this study. Instead the study focuses on international research. Neither have theses on master level been included since they are difficult to obtain and often written in local languages.

[2] http:/ www.gdmc.nl/3DCadastres

The a priori assumption that the analysis (for time reasons) could be based on the keywords describing the content in the publications was judged not to be scientifically reliable. The lack of an applied terminology within the 3D property field has sometimes made it difficult to determine what the sampled publications are covering. The reason was that in most cases the key words often are quite general (such as "3D cadastre", "legislation", "land management" and "GIS"). In some publications key words were absent. The abstracts were more informative in regard of describing the content of the publications, but were often not enough as basis for a reliable detailed classification. The majority of the publications were therefore studied by analysing the main text.

The publications were analysed before deciding on a for this study convenient classification. It was, however, in several cases not possible to classify the content into one group only, since the publications often deal with more than one subject, e.g. both legislation and registration. In such cases it has been judged which subject is the dominant one. The less dominating content(s), if any, have been registered as secondary content(s).

3D property is normally considered to be space delimited by some kind of boundaries. As important is that 3D property is a legal object separated from other legal object. Registration is then a way to make these objects public, often by the use of land administration systems. All this must be organised in one way or another. Therefore, the studied publications were classified into four groups, illustrating different aspects of 3D property; *legal, technical, registration* and *organisational*, as described in section 4.2. It must be noted that the classification of course is biased by the authors' interpretation of the analysed texts.

During the survey it has been noted that several conference publications "reappear" as journal articles after having been presented. In such cases the conference publication and the journal article has been treated as separate objects in the survey.

## 2. TERMINOLOGY

The process of publishing conference contributions, articles and other publications is a process of communication between the author(s) and their (mostly unknown) audience. Any communication process would however be of no or only limited value if there was no agreed method of communication, e.g. by having an established vocabulary defining a specific terminology. Terminology cannot be over-estimated in communication and information interchange. Without any agreement, it is not possible to achieve any effective communication or comparison.

There have been rather few scientific contributions dealing with the use of terminological principles in the real property domain, including 3D property, see e.g., Paasch (2005, 2007, 2008), Paasch and Paulsson (2011), Ruonavaara (1993) and Stuckenschmidt, Stubkjær and Schlieder (2003). Paasch and Paulsson (2011) did not reveal any existing international definition or terminology of 3D property possible to use internationally to differentiate forms of 3D property in their study on 3D property terminology. Most definitions seem to be based on national legislation and its national, specific characteristics of 3D property. The first

international workshop on 3D cadastres in Delft in 2001 brought up general questions regarding registration of properties in strata (i.e. in layers). One of the outcomes of the working session on legal issues concerned the question of what is "3D property" and whether or not it is possible to make a definition of this concept. The conclusion was that it to a large extent depends on the legal system and cultural background (FIG 2002). Paulsson and Paasch (2011) concludes that internationally it is possible to find different terminology for 3D property, which to a great extent depends on national terminology used in legislation, but that many definitions are technical, not legal, in nature. The definitions and descriptions often focus on the technical and registration aspects, rather than on the legal aspects.

"3D cadastre" is sometimes used as a general term for three-dimensional property, but often only to describe the actual cadastre, or real property registration system. Therefore, the term 3D property is used throughout this paper. Other terms for this concept can also be found. Not all of them include "3D" or three-dimensional as a component, which makes it difficult to discern what publications are really dealing with the 3D property issue. Some of them refer to "multi-functional" or "multiple", while others talk about "space" or "volume" or "horizontal subdivision". Three-dimensional property in common law legislation, stemming from the Australian legislation, is referred to by the terms "stratum" or "strata title". Apartment ownership is also a form of 3D property. A number of different terms can be used for this form as well, e.g. "condominium", "multi-storey building", "sectional ownership" or "unit title".

As mentioned, there are many different terms used for expressing the concept of 3D property. However, not exactly the same type of object or property is referred to by each of these terms. To find a general definition that would cover the meaning of all these terms would be difficult. Focusing on the three-dimensional aspect of this concept, a three-dimensional object can be defined as something that has an extent in length (height), width and depth. The purpose of a definition of 3D property is mainly to focus on the three-dimensional aspect and what separates it from the regular 2D property. Since the property concept itself is related to the legislation, in order to focus on the legal side of 3D property and not just the volume that is delimited, 3D property can be defined as "real property that is legally delimited both vertically and horizontally" (Paulsson and Paasch 2011).

## 3. LEGAL ASPECTS OF 3D PROPERTY

When looking at 3D property internationally, it is possible to discern different types of 3D property. If trying to classify these forms, there is a broad range of forms from complete independent ownership of a volume of space, to specific rights without ownership (Paulsson 2007). The specific features for each type depend to a large extent on the legal system in the specific country, but it is possible to categorise them in some types, which can be done in different ways. The forms of 3D property can vary e.g. when it comes to ownership and delimitation. The systems for 3D property develop with time, and new 3D property forms and matters connected with such systems can be added when a need has emerged with new phenomena and difficulties in society and the lack of solutions to them.

The structure, principles and rules for 3D property are basically similar for different countries and legal systems, but the practical problems that emerge are usually solved in specific ways for each country. The problems appear, however, to be the same (van der Merwe 1994, p. 15). From international studies, a number of key factors related to 3D property that seem to be important to solve and that are common for most forms and systems can be discerned. These include the delimitation of property units, the content of the definition of common property, the forms of cooperation between property units, management and regulation issues, as well as the settlement of disputes and insurance solutions (Paulsson 2007). More or less substantial amendments have been required in the statutes within these areas, with shortcomings still remaining after many years of use and changes still being made (Paulsson 2007).

Many difficulties are connected with comparative studies of legal systems, which have to be taken into account when interpreting the results of such studies. See e.g. von Bar (2004), Bogdan (1993 and 2004); David et al (1974); Van Hoecke (2004); Zweigert and Kötz, (1998). The fact that legislation and practice is constantly changing makes it difficult to keep a static perspective in the comparison. Even though rule-comparison is a common way of carrying out comparative legal studies, there are other ways of doing legal research. In order to understand the rules, their legal and non-legal context must also be considered.

## 4. CASE STUDY

### 4.1 Selected publications

The conference contributions analysed in this study were taken from 18 international conferences:

- FIG Working Weeks or International FIG congresses in 2001-2011;
- 3D property Nordic Conference in Stockholm, Sweden, 2010;
- 5th International 3D Geoinfo. conference in Berlin, Germany, 2010;
- 4th International 3D Geoinfo. workshop in Ghent, Belgium, 2009;
- Conference on Cadastral Infrastructure, Bogota, Colombia, 2005;
- 3rd international workshop "Towards a Cadastral Core Domain Model" of COST action G9, Delft, the Netherlands, 2002;
- UDMS 2002, 23rd Urban Data Management Symposium, Prague, Czech Republic, 2002;
- International workshop on 3D Cadastres, Delft, the Netherlands, 2001.

The majority of conferences were organised by FIG, which assigned specific sessions to the 3D property/3D cadastre topic in all conferences, except one. One conference had two sessions on 3D property/3D cadastre.

### 4.2 Classification

There have been different attempts to classify 3D property/3D cadastre topics. One attempt, in the forthcoming sessions of the second 3D Delft workshop, is to use four classes. 1) Legal framework 3D cadastres; 2) Initial registration of 3D parcels; 3) 3D data management; and 4) Visualization, distribution and delivery of 3D parcels. The chosen workshop topics cover

major aspects of 3D property research like legal issues, registration, data management and distribution of 3D data.

Another classification (Aien et al 2011) provides three general aspects of 3D cadastre; legal, technical and institutional. The legal aspect supports according to Aien et al (2011) the register of 3D properties in a 3D cadastre. Aien et al (2011) mention as examples that apartment owners are entitled to use a specific space usually on top of each other and the owners in most jurisdictions share implicit rights in the common areas. 3D property legislation does not support full 3D property representation in all jurisdictions. Aien et al (2011, p. 3) states that some countries have to develop their legal systems to support registration and representation of 3D properties. Technical aspects refer according to Aien et al (2011, p. 6) to the use and knowledge of methods, model and tools to perform 3D cadastre, such as the progress in computers, and data capturing methods. Cadastres are only meaningful when they work within an institutional context by e.g. defining tasks and responsibilities of the public administration empowered to register. The institutional aspects can, according to Aien et al (2011, p. 5), be divided into categories for e.g. execution and protection of regulations and the provision of unified 3D concepts such as apartment, 3D ownership, 3D property, etc.

From the authors' point of view it is more relevant to focus on legal, technical, registration and organisational questions in a classification, as this refers to the legal content of 3D property, the techniques of managing and storing such property and ways of registration. Organisation is more a question of efficiency. These four categories do not focus on 3D cadastral aspects, but on a classification which enables the comparison of different categories of 3D property publications without any reference to a cadastre or other land administration systems. Based on the case study, in the legal category key words such as real property rights, restrictions, responsibilities, real property, superficies solo credit, security of tenure, legislation, subdivision, spatial planning, legal objects and legal framework, LADM (the parts describing legal aspects) have been included. Subjects like database, spatial data infrastructure, data model, GIS, visualisation/geometrical representation, LADM (the parts not describing legal aspects), cadastral surveying, geometry, topology, exchange formats, distribution and delivery as well as data management all belong to the technical category. Spatial and temporal dimensions, data integration and height representation can be referred to the registration category. These key words may also be considered as technical, depending on the content of the publication itself. In the organisational category there are concepts such as institutional, management and capacity building. The categories are quite general and could be further subdivided, which however has not been done in this study. Furthermore, some publications may relate to two or more categories, e.g. how legislation interacts with registration or how technical changes are influenced by legislation. Several publications e.g. start by shortly mentioning legal aspects in the introduction but continue on to the technical or registration aspect without making any connection to the legal aspects at the end, and it is therefore doubtful whether to include them in the legal category.

### 4.3 Results

The contributions in the categories have varied during the studied decade. The largest contribution was in 2001, the first year of the period, when 26 publications where published in total in the 4 categories. The registration category was the most dominating with 11 publications, followed by 8 in the technical, 6 in the legal and 1 in the organisational category. After 2001 there was a decrease in publications, ranging from 2 to 15 publications in total per year. The year 2007 produced the lowest number of publications in the decade with 1 publication in the legal and technical categories each. The second highest number of publications was produced in 2010, with 6 publications in the legal and technical categories, and 3 publications in the registration category, but none in the organisational category. It is notable that there had not been any publications in all categories each year. No publications were made in the organisational category in the last 7 years. See table 1 for a compilation of these results.

In total 105 publications have been analysed. 28 publications were assigned to the legal category, 36 to the technical category, 38 to the registration category and 3 to the organisational category. The study showed that the number of publications in total have been rather constant for the three most dominant categories. From a legal perspective the legal category is in minority with 28 publications, compared to the total number of publications of the other three categories together, consisting of 77 contributions. The survey also showed that the majority of publications dealt with more than one subject. The number of secondary contents for each year and category are not part of the statistics, but are listed in brackets in table 1 below.

**Table 1. Surveyed 3D conference papers, articles and other publications 2001-2011**
**() = secondary subjects**

| Year | Legal | Technical | Registration | Organisational | Total/year |
|---|---|---|---|---|---|
| **2001** | 6 (8) | 8 (5) | 11 (5) | 1 (6) | 26 |
| **2002** | 2 (1) | 2 (2) | 4 (3) | 0 (1) | 8 |
| **2003** | 2 (2) | 1 (0) | 2 (4) | 1 (1) | 6 |
| **2004** | 3 (3) | 4 (4) | 4 (4) | 1 (1) | 12 |
| **2005** | 0 (2) | 4 (1) | 5 (0) | 0 (0) | 9 |
| **2006** | 2 (1) | 2 (1) | 3 (2) | 0 (0) | 7 |
| **2007** | 1 (0) | 1 (0) | 0 (0) | 0 (1) | 2 |
| **2008** | 2 (0) | 0 (1) | 2 (0) | 0 (3) | 4 |
| **2009** | 2 (1) | 3 (0) | 2 (1) | 0 (1) | 7 |
| **2010** | 6 (4) | 6 (2) | 3 (2) | 0 (2) | 15 |
| **2011** | 2 (3) | 5 (0) | 2 (5) | 0 (3) | 9 |
| **Total** | **28 (25)** | **36 (16)** | **38 (26)** | **3 (19)** | **105 (86)** |

The distribution of the surveyed publications per category and year is presented in figure 1 below.

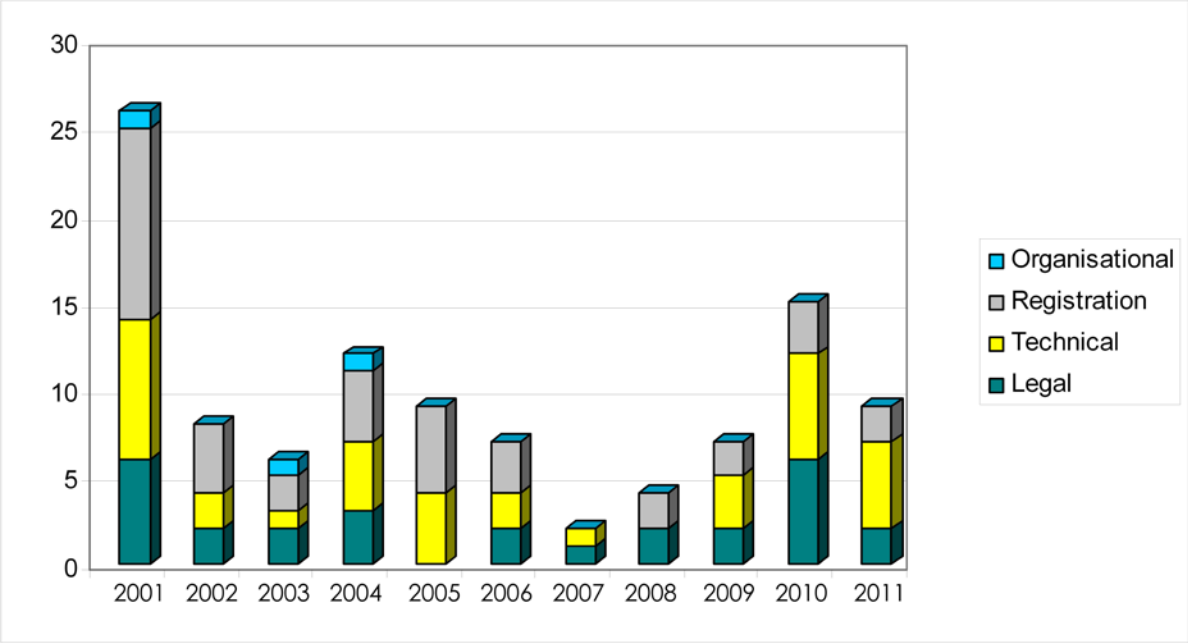


**Figure 1. The distribution of publications per category and year**

The selected publications showed a variety of sub-topics within each category. The legal category e.g. contains topics concerning the development of national 3D property legislation, the problems to be solved by developing 3D property legislation, the benefits and problems of applying 3D legislation. The publications in the technical category discuss a wide range of different topics. Examples are data modelling, data types and attributes, XML implementation, data management, data visualisation and development of cadastral systems. The publications in the registration category deal with e.g. how to technically register 3D property in cadastral systems, the visualization of registered objects and the registration in multipurpose cadastral systems. The publications in the organisational category cover the development of cadastral models, implementation of technical solutions into the organisational framework, etc. As can be seen from the above, the groups share some contents. The boundary line between addressing a publication to one group or another is depending on the actual content of the publication. For example, registration issues can be classified as belonging to the legal category or registration or technical depending on scope the publication.

## 5. ANALYSIS

From the study it is noticeable that the legal aspects constitute a rather small portion of the current research within the research on 3D property, especially when contrasting the legal category with the other three categories (technical, registration and organisational) combined, the difference is considerable. The registration category in this study is mainly regarded as a technical aspect, which would make it possible to consider the technical and registration categories as one in comparison with the legal category. In the classification it was sometimes

difficult to determine to which of the technical and registration categories that a publication should be referred.

Based on the survey a tendency that several articles cover more than a single area and not focus on one topic can be noticed. It was therefore difficult to make a classification of all articles. Of course, certain aspects might need to be presented as an introduction to the topic of the article. However, the scientific contribution could be more focused if publications would deal with one or maybe two topics and not include legal, technical, registration and/or organisational issues at the same time.

The publications have not been further classified within each category, but it can be noticed that there are few contributions concerning terminology or definitions in the publications in the legal category, or in the other groups. The results are in line with the conclusions from previous research in Paasch and Paulsson (2011). The workshop on 3D cadastre in Delft in 2001 discussed the terminology problems to some extent, but since then not much research related to this problem seems to have been carried out. The lack of a clear, main terminology for the general concept regarding 3D property makes it difficult to standardize what is meant by this. It seems that, for example, the term 3D cadastre sometimes is used to describe the actual property registration system(s), but at the same time also is used as a general term for three-dimensional real property. Due to this, it has not been possible to the same extent to use the key words in the publications as a guide for the classification, since they may signify different things for different researchers and authors.

The legal aspects can be seen as a foundation for 3D property. Without proper legislation, 3D properties cannot be formed at all. The technical, registration and organisational sides are of a more pragmatic nature. The legal foundation should be established first, before the application of a 3D cadastral system can be discussed. The results of this study show that the research in the field to a large extent is focused on more applied, technical aspects. If the legal foundation is already established, it does not, perhaps, have to be discussed and investigated that much further. However, it is not completely certain that the legal foundation is always there first. Technical, registration and organisational aspects are activities, processes, etc. in order to make the system function. Some researchers seem to presuppose that the legal foundation already exists and they describe problems and applications from that perspective.

When studying different systems for 3D property internationally, there are certain key factors that seem to be important for a successful and lasting system for 3D property, regardless of the form of 3D property and the legal system. Many of them relate to management aspects, which can be identified in the studied systems as an important area to create rules within. In this study, the management aspects have been referred to the organisational category, including dispute resolution and insurance solutions. This category is quite small in number, as can be seen from the results of the study. Other key factors are related to the delimitation of property units, the content of the definition of common property, the creation of easements and the forms of cooperation between property units, thus issues belonging to the legal category. Since these factors have created problems in 3D property systems, and have led to amendments and additions to the legislation in several countries, these questions must be solved and discussed within the scientific community.

Based on the results from the survey, the presented hypothesis is verified. The results are in line with results from previous work (Paasch and Paulsson, 2011). More focus is given to technical and registration aspects than to legal aspects when it comes to research within the field of 3D property.

## 6. CONCLUSIONS

The aim of this paper has been not only to investigate the field of 3D property in research, in order to find the occurrence of legal aspects, but also to raise the issue and promote further discussion about the need for more legal research on 3D property. Looking back on the recent ten years, from the first international workshop on 3D cadastre in Delft until the second workshop in 2011, it is noticeable that there is important research going on in many parts of the world. From the study the hypothesis that the non-legal aspects of 3D property are more researched than the legal aspects could be verified, when comparing the amount of research contributions within the different categories.

Two main problems can be identified from the study. One of them concerns whether there should be more specific legal research on 3D property or if it is sufficient to include such aspects in the research of other non-legal topics that can be found in the publications. The other problem is the lack of a clear standardized terminology within the field of 3D property.

The development of cadastral systems has merged the boundaries between registration, data management and visualisation of 3D property information. One system can be used for different purposes. The authors are aware that it may be practically impossible to establish domain specific key words covering all aspects of 3D property research. However, key words like “GIS” and “cadastral systems” seem to the authors to be too general to use, if the intention is to give an overview of the content of the publication.

Although there already exists a good foundation of results from research and other work on the more legal aspects of 3D property, e.g. the development of an ISO standard and the ongoing work of the FIG 3D cadastres working group, etc., the authors believe, both from personal experience within the terminology field and from this study, that more of fundamental research is needed and that more and focused attention should be given to the legal aspects of 3D property. Even though the existing and coming scientific publications on technical issues etc. are important, there should be more focus on basic research on legal aspects and within the terminology field. By making this statement, it is not claimed that existing research should be cancelled or transformed into legal studies, but rather that the legal aspects should be a topic for research on its own and not just as a background or introduction to more applied and technical research topics.

The conclusions from the study also include the recommendation that in order to promote the cooperation between researchers, especially from different countries, and to make it easier to find and understand research publications in the field of 3D property, the terminology within the field should be more consistent and standardised.

### 6.1 Future research

In future research of international interest more attention could also be given to establishing some foundation regarding legal system and terminology for 3D property, both nationally and internationally. It should be possible to achieve a common, conceptual framework allowing the exchange of legal 3D real property information within the cadastral domain. FIG Working group on 3D cadastre has started this task in a good way, but it could be further improved by adding individual research in different countries.

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## BIOGRAPHICAL NOTES

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