

LEARNING FROM OTHER COUNTRIES

From 2D Parcels to 3D Registrations

3D Cadastres: State-of-the-art

With the increasing pressure on land comes a growing interest in using space both beneath and above the surface. How should cadastral systems respond to this need? How should properties superimposed one on top of the other be reflected in the cadastral DataBase Management System (DBMS)? Many countries are working on modifying their Cadastral system more appropriately to reflect stratified usage and rights. The author presents the state-of-the-art in this area and discusses directions for future solutions.

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According to the FIG statement on Cadastres, a cadastre is usually, and in most countries, a parcel-based and up-to-date land information system containing records of interests in land (rights, restrictions and responsibilities). It usually includes a geometric description of land parcels, linked to other records describing the nature of the interests, the ownership or control of those interests and often the value of the parcel and any improvements that have been made to it. Some countries register apartments and other structures above or beneath the surface as property objects in line with parcels on the surface. In this article, the cadastre is seen in relation to land registration as

representing a system of land administration.

Vertical Dimension

With the increasing pressure on land there comes a growing interest in using space both above and beneath the surface. Examples are:

- ◆ Metro stations, subterranean parking places and shopping malls
- ◆ Subterranean railways and roads
- ◆ Constructions built on top of each other (Figure 1)
- ◆ Apartments
- ◆ Cables and pipes

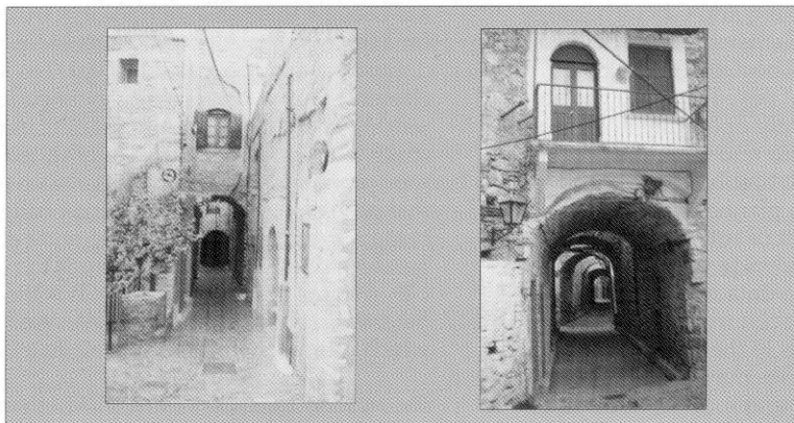
The use of strata rights, condominium rights, servitudes and rights of building today provide

FIG Initiative

This article is based on outcomes of the international workshop on 3D Cadastres which was organised at the Department of Geodesy, Delft University of Technology, in The Netherlands, from 28th-30th November 2001. This workshop, organised by Commission 7 (Cadastre and Land Management) and Commission 3 (Spatial Information Management) of the International Federation of Surveyors (FIG), provided a good starting point for the opening up of international discussions on 3D cadastres and an exchange over the status, experience and (planned) developments concerning the use of 3D cadastral registrations. This discussion requires an interdisciplinary approach, covering legal, technical and organisational aspects. All these disciplines participated in the workshop. The international discussion on 3D cadastres will be continued in the context of FIG during the planned FIG congress 2002 to be held in Washington, USA, and during the FIG working week 2003 in Eilat, Israel. The proceedings of the workshop here mentioned may be ordered at e.m.fendel@citg.tudelft.nl.

the solution to problems of definition in many countries. The legal boundaries are usually fixed in 2D space. However, for satisfactory definition and management of the juridical situation 3D information becomes indispensable. Although the current solution might seem sufficient, it may prove incapable of ensuring legal security in the future. Also registration of historical monuments, sections of historical buildings and areas of archaeological interest and of severe soil pollution all have a 3D component. Cadastral systems throughout the world encounter the complexity involved in attempts to reflect the vertical dimension in terms of legal status using the current registration possibilities based on 2D

Figure 1,
*'Building-bridges'
in Greece*



land parcels. This definition needs reconsideration when the use of space beneath and above the surface comes into play.

Implicitly 3D

In most countries, property rights are not limited in a vertical direction. They extend from the centre of the earth into the sky, although they are restricted by third party rights, such as those concerning mineral rights and rights of flying (Figure 2). As a consequence of this relative lack of restriction, cadastral objects are defined in 3D making cadastral parcels columns of space. Although current cadastral systems are based on a 2D map they are actually implicitly 3D. The task of the cadastre is to ensure the registration of the multi-functional use of space (Figure 3). This task aims at making rights concerning 3D situations certain, transferable and taxable. The concept of 3D property depends on the national legal system. In most countries, condominium rights or the registration of property in strata are used to register properties built one on top of another.

Current Solutions

The condominium right consists of:

- ◆ Share in an apartment (one or more buildings) and in the underlying ground
- ◆ Exclusive use of a certain part of this building

A drawing may form an obligatory component of the deed (for example in The Netherlands) in which the building is divided into individual apartments. This drawing should give a clear picture of the cadastral situation by showing an overview of every floor. On the cadastral map only the ground-level parcel is visible.

Strata titles are mainly used for units, flats, villas and townhouses. Buyers are given ownership of a part of a larger property. The communal areas are owned by all the proprietors. The condominium right gives the right of use of the individual unit, based on a share-holding, whilst the strata right gives the owners the ownership of the individual unit in their use.

Other solutions involve the right of building or the use of servitudes. In some cases, these rights are not spatially defined (such as in The Netherlands) while in other cases (e.g. in South Africa) they are represented in the title by means of maps and cross-sections. Land ownership is currently reasonably well registered, whilst objects such as apartments, buildings, tunnels and pipelines which are subject to real rights (servitudes, right of building) and which actually represent separate ownership, are not individually specified in the cadastre.

New 3D cadastral laws imply questions such as:

- ◆ Should it be possible to impose a right of building in the case of a tunnel or to expropriate a part of the owned space in the public interest?
- ◆ Should the registration of empty volumes (i.e. a volume not involving a construction) be possible?
- ◆ How should relationships be defined between parties, for example between the owner of a parcel and the owner of a tunnel? Do these relationships differ essentially from those between two horizontal neighbours?

Examples

Kenya, South Africa, Australia and Great Britain use strata title registration. Different terms (e.g. section) may be employed for more or less the same concept. In some cases it is possible to spatially define the 2D extension of a property on the cadastral map. The strata titles contain a drawing of the situation (complete parcel divided into individually owned units and commonly held property), augmented by the cross-sections of the different buildings. Greece distinguishes

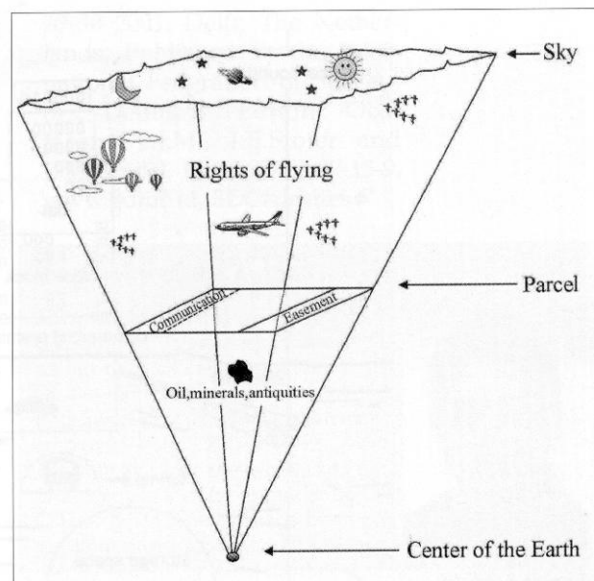


Figure 2, Rights over parcels spread from the centre of the Earth to the sky

horizontal ownership, which is similar to condominium rights, and vertical ownership, which is the ownership of independent building(s) built on a single parcel and co-ownership of the parcel. In Finland there exists specific legislation for housing stock companies. In such a company a shareholder has possession rights over certain premises (apartments) detailed in the articles of association. Apartments are not

Kenya, South Africa, Australia and Great Britain use strata title registration

clearly registered in public registers but only in the company real estate register. Also, premises built above and beneath the surface are not explicitly indicated on the cadastral map. However, up until now hardly any legal problems have arisen due to this apparent gap in registration procedures.

Coming Solutions

Some countries are working on legal solutions to the problems of registration of constructions beneath or above the surface. Norway has proposed a law on 'construction properties'. This law enables registration of a 3D construction above or beneath the surface. It is assumed that the law

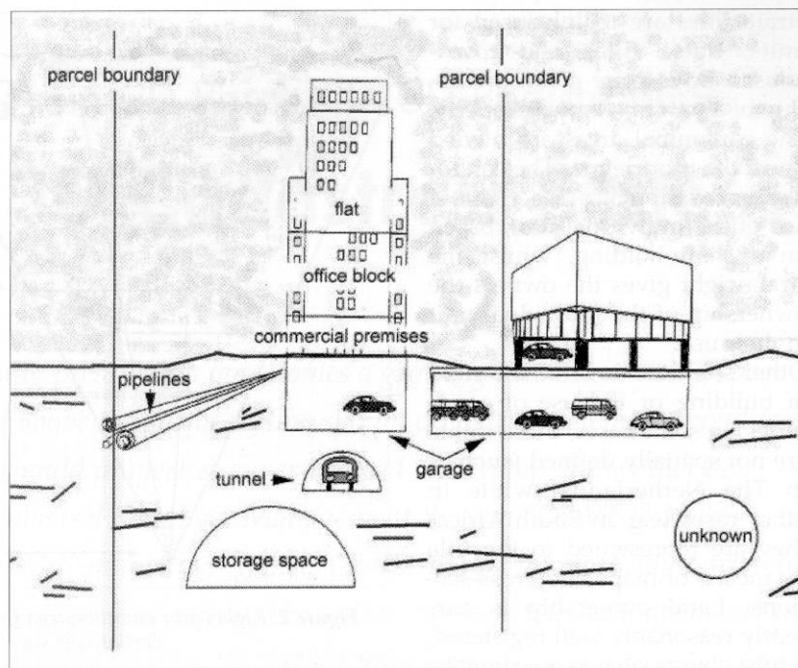


Figure 3, Multi-functional use of space

will be adopted by the Norwegian parliament in 2002. Legislative work is currently also in progress in Sweden aimed at facilitating the formation of properties in strata by the registration of '3D property units'. This proposed law may, however, come into force no earlier than 2003.

The free construction of property units will be inhibited by any such laws. The proprietary definition of a construction will only be possible when it relates to a construction, like a building or a bridge. Therefore it will not be possible to create 'air space parcels' as happens, for example, in British Columbia in Canada. In Norway, a proprietary construction will cease to exist should the actual construction to which it alludes collapse and not be rebuilt within three years. Establishing a condominium right prevails over the establishment of a construction property. The establishment of property units has also to respect local planning and building regulatory systems. In Sweden, a building may be divided into different property units, whilst in Norway only the entire building may be considered as a construction property. Although administratively described in 3D, these properties are not yet spatially defined in the DBMS of the cadastre. In Norway, such constructions are made visible on the (2D) cadastral map with a special line style, while in

Sweden it remains to be examined how these constructions should be documented, how they are to be registered or how they will be made visible on the cadastral map.

Research in Progress

Israel faces high pressure on the use of land because it is so intensively used. This has there pushed forward developments for a 3D Cadastre. A two year long research and development project, initiated by the Survey of Israel, has begun into the registration of the right of lands in three dimensions. This plan has an interdisciplinary approach in which legal and technical, as well as organisational aspects, are considered. At the Geodetic Engineering Division of the Technion-Israel Institute of Technology, research has begun dealing with geodetic and cadastral aspects of utilising space above and beneath the surface. In the city transportation centre of Modi'in, a large scale project is underway, including buildings, roads, tunnels, a railway station, a bus station and more. This project has already been used to examine the current land registration system in Israel and is now being used to study the possibilities for 3D registration. Mid European countries such as Hungary, The Czech Republic and the Republic of Slovenia are in the phase of exam-

ining the current cadastre for potential registration of 3D properties, including apartments. In The Netherlands, research is being carried out at the Department of Geodesy (Delft University of Technology) in collaboration with the Dutch Cadastre to study the needs, constraints and possibilities for the development of a 3D Cadastre. The proposed approach is that of the registration of 3D world objects in the cadastral DBMS (both administratively and spatially) as an extension of the 2D cadastral DBMS. International marine cadastres traditionally have a 3D approach, as the use of the marine environment is volumetric by nature and involves rights to the surface, water column, seabed and subsoil. The University of New Brunswick (Canada), Department of Geo-desy and Geomatics Engineering is developing a 3D marine cadastre to support effective and efficient decision-making associated with marine governance.

Discussion

The use of strata rights, condominium rights, servitudes and rights of building provides the solution for problems associated with the registration of real estate built beneath and above the surface in many countries. Although this solution seems sufficient, it

Mid European countries are examining registration of 3D properties

may prove incapable of ensuring legal security in the future. One disadvantage in relation to 3D units is that they may not be (totally) visible on the cadastral map or in the DBMS and that they are not available in any other digital form. In addition, linear objects, such as tunnels, which may cross different parcels, need to be divided into legal objects which match parcels at the surface. The object itself cannot be used as a basis for registration. Such difficulties may be avoided by the establishment of different cadastral layers; for

example, providing support for three cadastral layers: one layer representing the surface, one the region lying beneath the surface and one the region above the surface.

Concluding Remarks

Although legislation has made progress in some countries, none have implemented the possibility to spatially define properties in 3D in the cadastral DBMS. It is becoming simple to collect data in 3D (by means of GPS). However, it will take a tremendous job to recollect all parcel boundaries in 3D. How should properties superimposed one on top of another be reflected in the cadastral DBMS: as properties in strata, as a set of 2D layers or as individual 3D parcels? The final solution would be the definition of 3D parcels or 3D legal objects within the current cadastral system. Since 2D parcels remain sufficient for many purposes, it

might be efficient to begin with the 2D parcels (actually 3D columns) and extend this into the registration of 3D objects when the situation so requires. Relationships between 3D objects and surface parcels must be well defined, either explicitly stored in the DBMS or to be retrieved by spatial functions.

Acknowledgement

All figures in this article are taken from the congress proceedings. We thank dr. Dimitris Rokos (courtesy of Mrs. Fragiskou) from the Hellenic Cadastre (Figure 1), dr. Joseph Forrai and Gili Kirschner from the Survey of Israel (Figure 2), and Mrs. Barbro Julstad from the National Land Survey of Sweden (Figure 3) for providing the illustrations.

Further Reading

- ◆ Proceedings of the International Workshop on '3D Cadastres', Registration of properties in strata, November

28-30 2001, Delft, The Netherlands, Published by the International Federation of Surveyors, Denmark, Editors: Oosterom, P.J.M., J.E.Stoter and E.M.Fendel, ISBN 87-90907-15-9, www.gdmc.nl/3DCadastres◆

Biography of the Author

Jantien Stoter (MSc in Physical Geography, 1994) began her career as a GIS specialist with the District Water Board of Amsterdam and Surroundings, where she was employed from 1995 to 1997. From 1997 until 1999 she worked as a GIS consultant at an Engineering Office. Since 1999 she has been an assistant professor in the GIS technology section of the Department of Geodesy, Delft University of Technology. She is currently working towards a Ph.D. in 3D cadastres.



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