

## **CONCEPTUAL MODELING OF REAL PROPERTY OBJECTS FOR THE HELLENIC CADASTRE**

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### **ABSTRACT**

As it has been widely realized for quite some time now, land parcels are not the only real properties that are involved in a cadastral system. An accurate representation of all real properties, as defined in a Country's Civil Law, is of great importance for the development of an effective and fully operational digital cadastre. This paper focuses in the problems, which arise from our attempts to better represent all types of real properties for the Hellenic Cadastre. These problems, which became evident through the process of collecting cadastral data over different regions of the Country, refer to the definition and interdependencies of their representations mostly because of their spatial characteristics. Both 2D and 3D aspects have been taken into consideration in order to achieve a scheme that effectively encompasses all types of real properties. This paper presents some of the solutions to these problems that may not lead to the development of a real 3D cadastre but offer a reliable representation of real properties for an operational digital cadastral database.

### **INTRODUCTION**

The Hellenic Cadastre is one of the largest national infrastructure projects of modern Greece. KTIMATOLOGIO S.A. which has undertaken the development of the Hellenic Cadastre is responsible not only for the contracting, supervision and quality control of the cadastral survey studies, but also for developing the necessary infrastructure, which will support the operation, maintenance and updating of the Cadastre.

Serving this latter role, KTIMATOLOGIO SA has undertaken a series of projects one of the most prominent of which has been the development of the data and process model for the Hellenic Cadastre. To conduct this study, a multidisciplinary team of IT specialists, surveying engineers and lawyers was formed.

The purpose of this paper is to present the part of the results of the work of the Data and Process Model Working Team, which refer to the conceptual model of all the real property objects maintained by the Hellenic Cadastre. The Law 2664/1998, which describes the basic terms of the operation of the Hellenic Cadastre, sets as one of the principles of the Hellenic Cadastre that it will be parcel-based. Although this was set as a principle to ensure the geographic / spatial character of the Cadastre, it was soon realized that a more careful treatment of all the real property objects was needed. Real property objects other than land parcels such as different types of apartments (horizontal and complex vertical ownerships), buildings / parts of buildings (vertical ownerships or special customary ownership to buildings) and mines are maintained by the Hellenic Cadastre. To deal with the issues arising from this complex legal environment, the approach adopted in this paper was the following:

First, based on the existing legal framework (the Greek Civil Law and the two laws for the development and the operation of the Hellenic Cadastre), all the real property objects, which are collected and maintained by the Hellenic Cadastre, were defined. Based on this framework an initial attempt was made to model the basic real property objects for the purpose of collecting the cadastral survey data. This approach was developed having the land parcel as the basic element of the database of the Cadastre and it is presented in the form of an Entity – Relationship (ER) diagram.

Following that, experience gained from the pilot cadastral survey studies is used to identify a series of problems that arise from exceptions to the legal definitions of real property objects, as well as, situations arising from adverse possession of parts of real properties. Many of these issues are caused because of the need to model real property objects, which in reality are 3D, and several of them are often overlapping. The approach used to better model these cases is developed by attempting to come closer to the actual legal definitions of the real property objects without creating extremely complicated data structures.

This effort resulted to an extended all-encompassing conceptual model for real property objects for the Hellenic Cadastre, acknowledging their 3D nature and taking into consideration all the peculiarities of the Greek real property legal framework.

## **THE PROJECT OF THE HELLENIC CADASTRE**

The project of the Hellenic Cadastre was initiated back in 1994 by the Minister of Environment, Physical Planning and Public Works, based on an initial study by the Technical Chamber of Greece. However, the legal and technical framework of the project has been developing ever since (for example law 2308/1995 dealing with the procedures of the development of the Cadastre, Technical Specifications (1997), law 2664/1998 dealing with the operation of the Cadastre, Technical Specifications for producing Forest Maps (1999)).

The goal of the project is the development of a uniform, systematic and always up-to-date collection of registrations, which consist of the geometric description and the ownership status of all the real properties of the country, overseen and guaranteed by the State. Additionally, the Hellenic Cadastre may accommodate a wealth of additional information necessary for the growth and development of the Country.

The development and operation of the Hellenic Cadastre was assigned by law to the Hellenic Mapping and Cadastral Organization (HE.M.C.O.). However, to deal with several practical issues, KTIMATOLOGIO S.A., a private company owned by the State, was formed and was assigned the task of the development of the Hellenic Cadastre.

### **The development of the Hellenic Cadastre**

The development of the Cadastre in Greece is taking place in distinct phases called "Programs". In each phase, areas selected in different parts of the Country are contracted out following an international tender based on the EEC 92/50 Directive. In each of these areas the contractor has to carry out an extensive study that includes the following steps:

1. Signing of the Contract
2. Preliminary study:  
The contractor gets better acquainted with the area under cadastral survey, identifying all the characteristics and peculiarities of the area which relate to the task of developing the cadastre and quantifying all the elements of the study. The contractor must also identify all existing maps or other form of cadastral information which could be of use.
3. Development of the base maps:  
Air photos of the area under cadastral survey are taken and orthophotomaps are developed. Based on these, base maps are produced in scales 1:1.000 for urban areas and 1:5.000, for agricultural, forest and other areas.
4. Development of forest maps  
In the context of a cadastral study, forest maps are developed photogrammetrically, using recent air photos, as well as air photos taken back

- in 1946 or 1960. Forest maps do not exist at present for most parts of the country, they are, however, necessary for the development of the Cadastre because forest areas have a specific legal status in Greece, as in many other countries.
5. Collection of declarations of property rights:  
The contractor has to collect from all natural and legal persons declarations of property rights for all the real properties in the area. Only the State is not obliged to complete the declaration forms, but in many cases it does so in order to secure the rights to State land.
  6. Production of preliminary cadastral maps and tables:  
In the orthophotomaps which have been produced in earlier steps, the contractor identifies the boundaries of all real properties in the area under cadastral survey. This information is completed and verified by additional field observations and measurements to produce the preliminary cadastral maps. The information from the collection of the real property rights declarations is analyzed, organized in cadastral tables and associated with the corresponding real properties in the preliminary cadastral maps.
  7. First public Presentation (“Suspension”) of the declared property rights:  
The preliminary cadastral maps and tables are presented in public, so each right holder can check the preliminary registrations in the cadastre.
  8. Submission of Objections:  
If a right holder identifies an erroneous registration in the cadastral maps and tables, he can submit an objection.
  9. Judging the Objections  
A specially formed 3-member committee (in which a judge is presiding) decides on all the submitted objections.
  10. Correction of cadastral maps and tables based on the ruling of the Objection Committee:  
The cadastral maps and tables are corrected/ updated accordingly
  11. Second public Presentation (“Suspension”) of the declared property rights:
  12. Submission of Appeals
  13. Judging the Appeals  
A new 3-member committee is formed which rules on the submitted appeals
  14. Correction of cadastral maps and tables based on the ruling of the Objection Committee
  15. Completion of the Cadastral Survey and making the first registrations in the Cadastral Books and Maps.

## REAL PROPERTY OBJECTS

KTIMATOLOGIO SA, realizing its goal of developing the necessary infrastructure, which will support the operation, maintenance and updating of the Cadastre, has undertaken a series of projects one of which has been the development of the data and process model for the Hellenic Cadastre. To conduct this study, a multidisciplinary team of IT specialists, surveying engineers and lawyers was formed. One of the first realizations of this team was that cadastre is not dealing just with land parcels but rather with real property objects.

The concept of a “land object” has been formally introduced in the Statement of FIG for Cadastre 2014. As Kaufmann claimed:

“Cadastre 2014 is not based on traditional procedures grown during the times and put into force by accident. It is not only dealing with private property parcels. It is focused on the legal land objects, from which the parcel is just an important one, determined by the private and public laws of a certain country.” (*Kaufmann J., 1999*).

In order to identify and define the real property objects for the Hellenic Cadastre, one has to study the legal framework in effect for real properties (Greek Civil Code), the two laws describing in broad terms the development and the operation of the Hellenic Cadastre (Law 2308/1995 and Law 2664/1998) and the existing registration system of the Mortgage Offices.

## IDENTIFYING AND DEFINING REAL PROPERTY OBJECTS

It is not relevant to the purposes of this paper to go into great depths in the real property legal system of Greece. However, in order to model real properties for the Hellenic Cadastre, one has to know at least the legal definitions of the basic real property entities. The basic real properties for the Hellenic Cadastre are the following:

- Land parcels
- Horizontal ownerships
- Vertical ownerships
- Composite vertical ownerships
- Special property objects
- Mines

### Land parcel

A land parcel is defined as a uniform area that constitutes a single, independent area of land, which may belong to one or more persons *ab indiviso*. The land parcel comprises the surface unit which is used as a reference for all cadastral data. As specified by the Law, ownership to a land

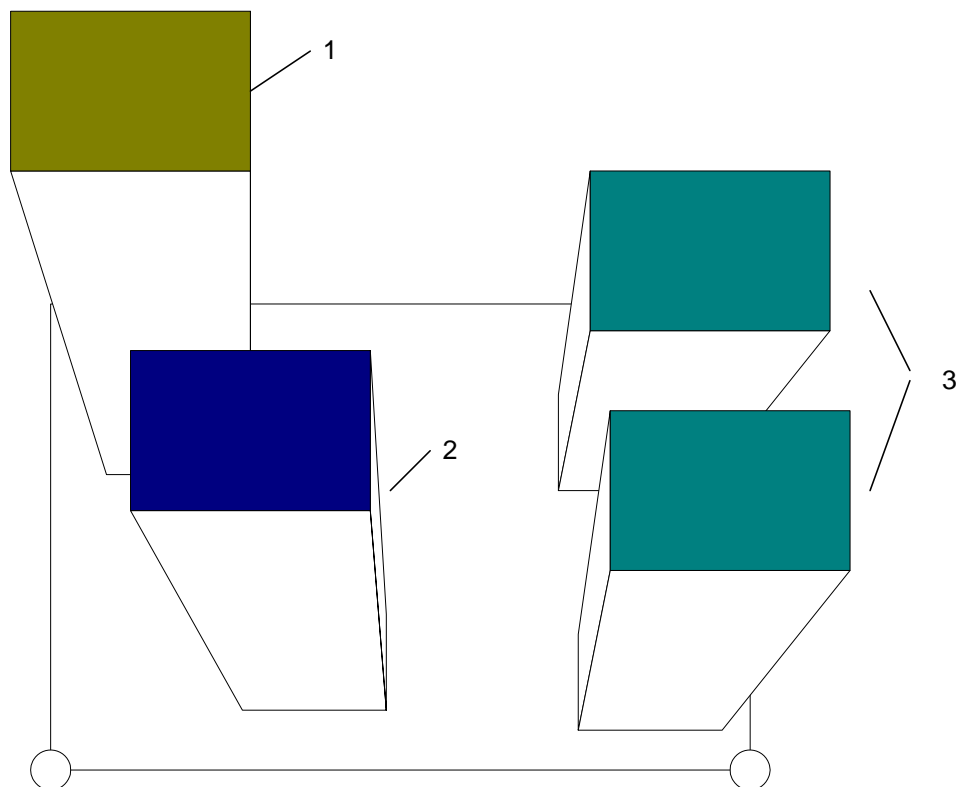
parcel extends to the overlying air column and the underlying soil. This extended ownership may be limited in some cases (i.e. mines).

### Horizontal ownerships

A horizontal ownership (apartment) is the independent ownership of a building's floor or apartment with simultaneous co-ownership in the public areas of the building and the land parcel.

### Vertical ownerships

A vertical ownership is the separate ownership to independent building(s), which are built or are planned to be built on a land parcel and the simultaneous co-ownership of the land parcel (Figure 1).



*Figure 1: Developing 3 vertical ownerships on a land parcel.*

## **Composite vertical ownerships**

A composite vertical ownership is the ownership of an independent partitioned property (i.e. horizontal property), in a land parcel where vertical properties have already been created, and the simultaneous co-ownership to the land parcel.

## **Special real property objects**

The term special property object is used in relation to the rights set out in articles 58 & 59 of the introductory law to the Civil Code referring to the right to plant, exploit the surface and the separate ownership of plantations or trees or buildings. This means that a different person may own a building or a plantation from the person who owns the land parcel on which they lie on. Ownership to a building under this legal status does not mean co-ownership to the land parcel.

## **Mines**

Another property object that extends under the earth's surface and is independent of the overlying land parcels is the mine. Ownership to a mine provides the right to search, mine and exploit mining minerals. It should be made clear that ownership to a mine, does not imply ownership to the corresponding land parcels on the surface of the land. However, the use of these land parcels must be such that does not obstruct the exploitation of the mine.

There are over 160 types of legal transactions that the Civil Code allows for all the types of real properties mentioned above. It is apparent that all transactions that refer to partitioned properties (horizontal, vertical and complex vertical ownerships), have a direct effect on the rights of the underlying land parcel, as ownership to a partitioned property implies co-ownership of the land parcel (to a specific percentage).

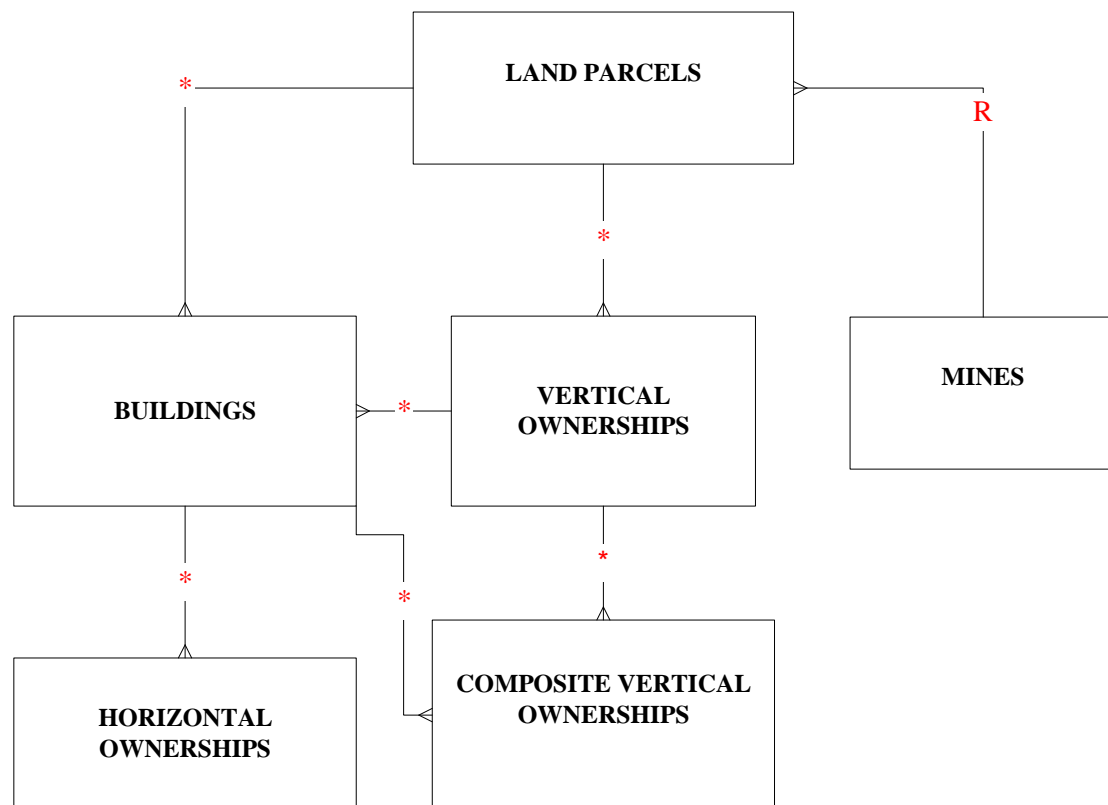
## **INITIAL MODELLING APPROACH**

Based on the definitions above and on what one expects to face in reality, the following conclusions were initially drawn and used to conceptualize real properties:

- The basic real property element of the Hellenic Cadastre is the land parcel (law 2664/1998).
- Buildings belong to land parcels.
- Each building falls completely within a land parcel.

- Vertical ownerships belong to land parcels.
- Buildings belong to vertical ownerships
- Horizontal and composite vertical ownerships belong to buildings.
- Composite vertical ownerships also belong to vertical ownerships.
- A mine does not belong to a land parcel but may exist underneath several of them.
- Special real property objects do not need to consist a separate real property object.

Based on these assumptions the following model was initially developed (Figure 2):



*Figure 2. Initial conceptual modelling of real property objects for the Hellenic Cadastre.*

In this approach, only three types of real properties have a spatial representation, in distinct thematic layers: land parcels, buildings and mines. Each instance of these real property types is represented by a polygon in the corresponding layer, having a one-to-one correspondence.

On the other hand, all partitioned properties (horizontal, vertical, complex vertical) do not have a spatial representation. However, it should be noted that there is a reference pointer that relates horizontal, vertical and complex-



vertical ownerships with the corresponding land parcels and buildings and thus to their spatial representation.

Part of the information of the 3D character of partitioned properties is recorded in attribute fields, i.e. the building's floor of an apartment, but other information such as the exact position of an apartment in a building (for example using coordinates) or the apartment lay-out are not collected.

If more spatial information were to be collected stored and maintained for the partitioned properties, the cost of the project of developing the National Cadastre in Greece would increase significantly and at this point in time, this was not considered necessary. The information that is being collected (building id, floor number, property id in the notary deed that establishes the partitioned property and its area) may not be enough to cartographically represent these objects, it is, however, enough to uniquely identify each one of them, thus allowing the effective operation of the cadastre, even on these objects.

In the case of mines, the following should be noted:

Mines as we all know are 3D real property objects that exist under the earth's surface. However, their legal definition consists only of a polygon that is roughly delineated on the surface. Consequently, for all legal transactions, a 2D polygon representation is sufficient for modelling a mine. By defining a distinct thematic layer for mines, one can maintain them independently from the overlying land parcels. This is preferable because there is no relation of property rights on mines with the rights of the overlying land parcels, as well as the scales which are best fit for cartographically representing mines are much smaller than those for land parcels.

## **PROBLEMS RELATED TO THE 2D AND 3D REPRESENTATIONS OF REAL PROPERTIES**

Based on the actual evidence collected during the pilot cadastral survey studies, several of the assumptions set earlier proved to be mistaken. Most of these issues that have arisen concern the 2D and 3D nature of the real property objects, and are briefly presented in this section:

### **Discontinuity of land parcels**

Land parcels, by definition, are continuous areas. However, there is one special case in which land parcels may not be continuous in space. Such land parcels are produced by the Organization for Housing of Workers (OHW). This situation is illustrated in Figure 3. In a large continuous land parcel (A), the OHW develops roads and other public areas, which in reality dissect the original land parcel (A1, A2, A3). When, however, a series of apartments (horizontal or vertical properties) are created within this parcel (in each of

the buildings 1, 2, 3, 4, 5), each one is assigned a co-ownership percentage to the entire, discontinuous now, land parcel (co-ownership in A1+A2+A3 instead of A).

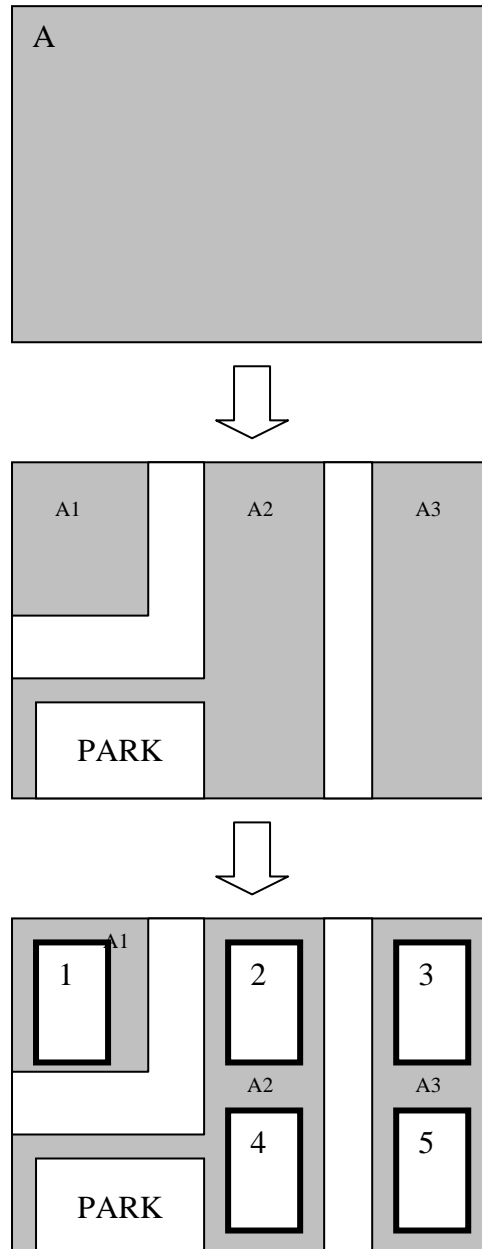
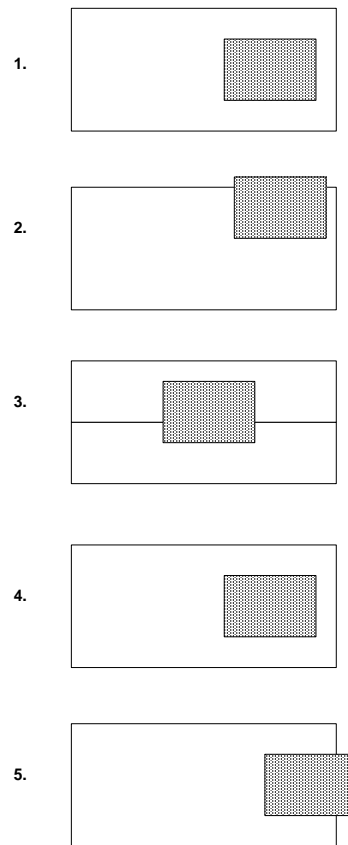


Figure 3: A special case of a land parcel.

**Buildings and land parcels**

Although, in the initial modelling approach, it was assumed that a building lies completely within a land parcel, in practice a variety of other cases of relationships between buildings and land parcels were identified (Figure 4):



*Figure 4: Relationships between buildings and land parcels.*

- One or more buildings may lie wholly within one land parcel (case 1) and the owner of the parcel has the ownership of the building(s) on it. This is the most commonly encountered case.
- A building may extend beyond the boundaries of a land parcel due to adverse possession of private or public land (case 2). This is often the case when an owner of a land parcel takes advantage of the inactivity (usually due to absence) of the owner of a neighboring parcel and builds a construction that extends beyond the boundaries of his/hers land parcel. This case is also encountered in buildings constructed partly in public land such as forests or coasts (in several cases due to lack of official delineation of the boundaries of forest or coastal areas but in other cases due to purposeful encroachment). In all these cases, the trespasser, legally, has only the ownership of the part of the building that resides within the boundaries of his/hers own land parcel.
- A building may be erected on two or more land parcels which were not officially amalgamated (case 3) (usually with a notary deed) although they belong to the same owner(s). In this case, the owner of the land parcels is the rightful owner of the building on them. However, since the land parcels are not officially amalgamated, they may be managed separately

by the owner (for example one of them may be sold or mortgaged) and such actions affect the parts of the buildings located in each one of them.

- There may be a right to separate ownership on a structure, part of a structure, trees or a plantation within a land parcel (see earlier the special property objects). This is a kind of property right that existed prior to the development of the Civil Code, and is maintained as such only for all the properties that were created before its establishment. Based on this, two situations may arise:
  - The object of the separate ownership (a whole building, a part of a building, or a plantation) belongs to someone other than the owner of the land parcel without any horizontal or vertical ownership having been established (case 4), or
  - A building may extend beyond the boundaries of a land parcel but it belongs as a whole to it (case 5). This situation is quite common in several islands in the Aegean Sea, where in settlement areas with steep relief, part of a building may be subterranean and extend beyond the boundaries of the land parcel or a building may extend over a road (Figure 5).

It is clear from the aforementioned cases that many buildings may be situated on a land parcel but a building may also be located on more than one land parcel.



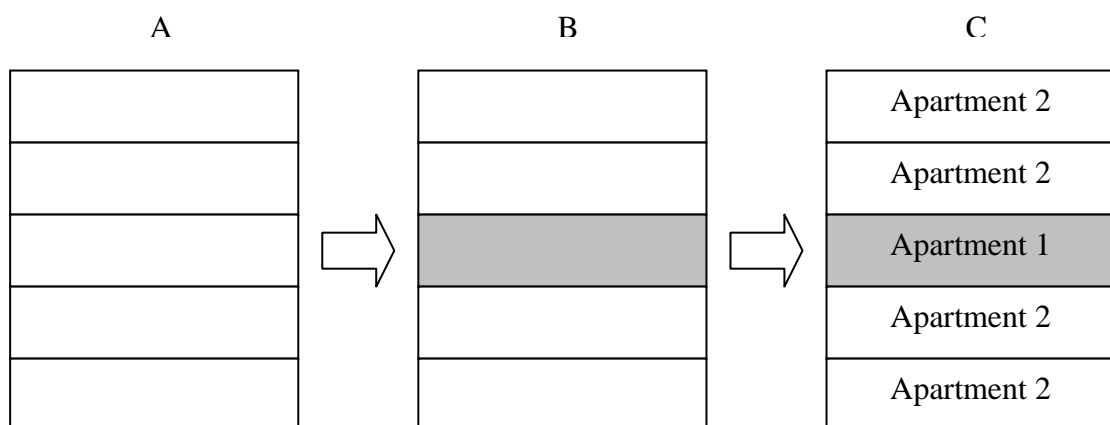
*Figure 5: Buildings extending over roads in island settlements  
(the picture is courtesy of Mrs. M. Fragiskou).*

### ***Partitioned properties and buildings***

Traditionally, when one thinks of a partitioned property it is easy to conceive it as a part of a floor of a building. Consequently, the initial, modeling approach of the partitioned properties was the one diagrammatically presented in the following figure.

Simply speaking, a land parcel has on it buildings which have in their turn apartments on specific floors. This logic was also used in developing the identification key for the partitioned properties. However, this approach had several shortcomings:

- Partitioned properties can be created (by a notary deed) on a land parcel before the corresponding building is built. Such properties legally exist since the registration of the deed, and therefore, they can be sold or mortgaged anytime after, independently of the construction of the building.
- There are certain cases in which an apartment may extend in two adjacent floors. In this case, one cannot associate only one floor to the particular apartment.
- Two adjacent apartments in two adjacent buildings may be amalgamated with a notary act into one. The new apartment will then belong to both buildings.
- Finally, if the owner of a multi-storey building, in which no partitioned properties have been created, decides to sell one of the floors, then automatically the rest of the floors legally become another apartment even if the floors of that apartment may not be continuous. (See Figure 6).

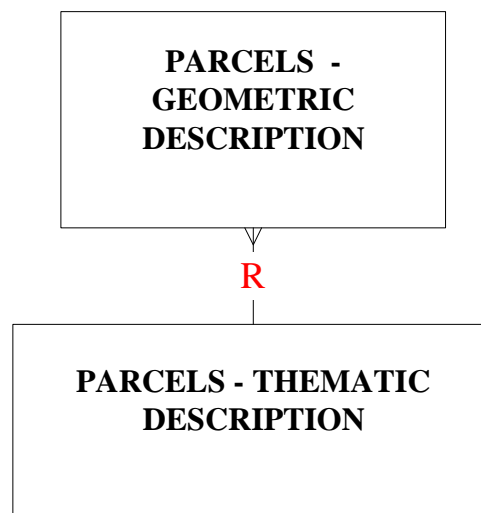


*Figure 6: A) The whole building belongs to a certain person. B) The owner decides to sell the third floor to another person. C) With the notary deed of selling the third floor, two apartments are legally created (1 and 2). Notice that apartment 2 is discontinuous.*

## PROPOSED SOLUTIONS

### Discontinuous land parcels

To deal with the problem of discontinuous land parcels in which one land parcel may be comprised from several polygons, the geometric representation of a land parcel is detached from the land parcel as a legal entity (thematic description) and two separate entities are created. This is diagrammatically represented with the following Figure 7.



*Figure 7: New approach in modelling land parcels.*

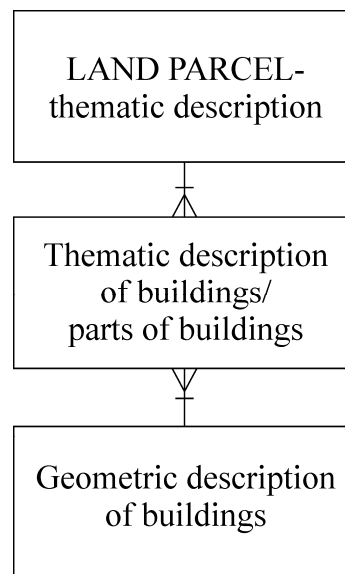
### Buildings

In order to deal with the problems, which relate to buildings and land parcels, the following scheme is proposed:

Similarly to the way we treated land parcels, the characteristics of buildings are organized into two separate entities: the entity ‘buildings/parts of buildings - thematic description’ and the entity “buildings – geometric description” (Figure 8). Buildings extending over one land parcel are conceptually separated into individual parts each one falling entirely within one land parcel. Each of these parts is a separate instance of a “building/part of building - thematic description”, along with all buildings falling entirely within that land parcel.

At the same time the buildings as distinct objects remain intact via the Buildings-Geometric Description entity, and they are associated with the respective land parcels via the of buildings/parts of buildings-thematic description entity.

In this manner, buildings-geometric description is a building record which can be completed with additional information about the construction itself (including plans and even pictures). This record can be maintained by the Town Planning Department of the Ministry of Environment, Physical Planning & Public Works which is the authority responsible for building permits. On the other hand, Buildings-thematic description, which are the legally recognized ingredients of a land parcel are properly associated with the respective land parcels, thus accomplishing a more complete description of the legal ownership status of an area. It is obvious that each building-Geometric description is associated with the buildings-thematic description which comprise it (one or more).



*Figure 8: E-R Model for land parcels and buildings.*

Special real property objects are considered as separate real property entities (see next figure) in order to represent more realistically and consistently the special ownership status of these properties. Special real properties belong to the land parcel that they fall in, however, their owner may be different from the owner of the land parcel. By considering them as separate entities existing on specific land parcels, we can associate different rights on them without losing reference of their position in space.

### **Partitioned properties**

From the problems described earlier it is evident that identification of partitioned properties cannot rely on the building id and the floor number, as these may not be reliable characteristics for unique identification of a partitioned property.





## CONCLUSIONS

A complex legal framework, such as the one in place in Greece, generates several issues that need to be resolved in order to represent real properties in a digital cadastral database. This paper illustrates the difficulties of modeling real property objects when taking into consideration their 2D and 3D characteristics.

Through, analyzing the specific problems that have been identified while collecting cadastral data, new approaches have been developed to deal with them. The cases of apartments (horizontal, complex vertical ownerships) and vertical ownerships which are real property objects with spatial characteristics in 3D, are dealt in a manner that allows their successful definition and description for cadastral use, not by modelling their spatial representation in 3D, but rather by, developing a set of relatively complex relationships to match the legal reality. Also, buildings and their relationships with land parcels are analyzed in depth and new entities are proposed and relationships remapped which allow the representation of both the real world characteristics and the legal status of real properties.

This paper may not be able to fully address all the issues that arise for a 3D cadastre, but it certainly proposes solutions that can conceptually expand traditional modeling approaches, to allow better modeling of 2- and 3D representational issues of real property objects.

The performance of this approach remains to be seen as the information system for the Hellenic Cadastre is, currently, under development.

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