

«On the Nature and Relationships of 3D Cadastral Objects»

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From 2D to 3D Cadastres

Main characteristics of 2D cadastres



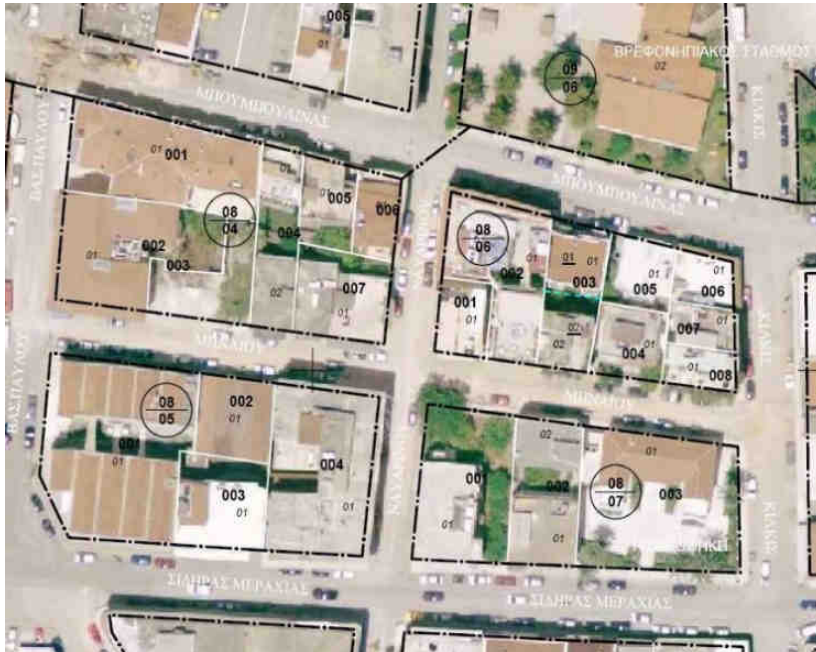
Typical cadastral map showing land parcels and buildings in an urban area in Greece

- Main stream cadastral systems have been built using 2D land parcels as their primary building block
- Land parcels are depicted on 2D maps and are associated with thematic, legal, and/or fiscal information associated with them
- All information is represented and managed within the scope of a 2D paradigm
- Migration from 2D to 3D cadastres requires reconsideration of the fundamental concepts of the cadastral domain and analysis of their manifestation into a 3D setting
- The goal of this presentation is to make a contribution in the theory of 3D cadastral systems by highlighting some key aspects of the cadastral domain as we move from a 2D to a 3D perspective
- The analysis is made primarily for a “legal cadastre” and for the Greek case



From 2D to 3D Cadastres

The nature of principal cadastral objects



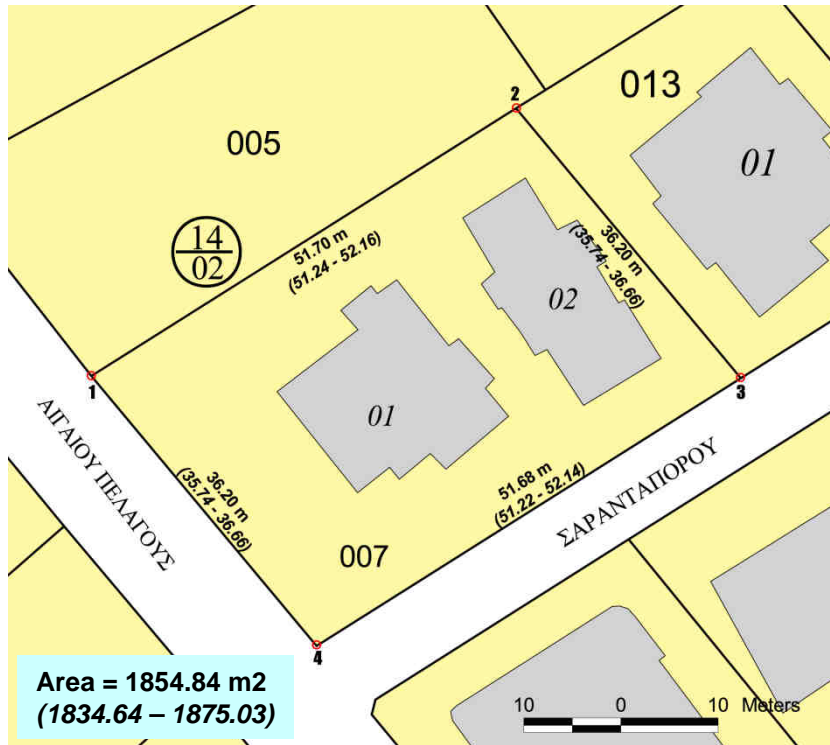
Typical extract of a cadastral map in an urban area in Greece having an orthophotomap as background

- In 2D cadastres the fundamental building block is the land parcel
- In legal cadastres the land parcel is defined as the continuous area of space in which the ownership rights are the same (the person or the set of persons)
- Parcel boundaries indicate changes in the ownership rights left and right of their position and show the extent to which an owner (or a set of co-owners) can exercise their ownership rights
- Similar arguments are valid for other types rights or restrictions of rights that may exist on properties



From 2D to 3D Cadastres

The nature of principal cadastral objects



An extract from a cadastral map (Lolonis, 2000, “Representation and Management of Spatial Error in Cadastral Databases”)

- In the 2D paradigm, cadastral maps are a very effective tool for portraying this kind of information (rights, restrictions etc.)
- The definition of land parcel boundaries is quite crisp and clear
- There may be disagreements among neighbors about the exact position of land parcel boundaries or arguments about the accuracy of their measurement but the concept of boundary is clearly defined
- This is a consequence of the power of owners to exercise their ownership or other types of rights on those properties



From 2D to 3D Cadastres

The nature of principal cadastral objects



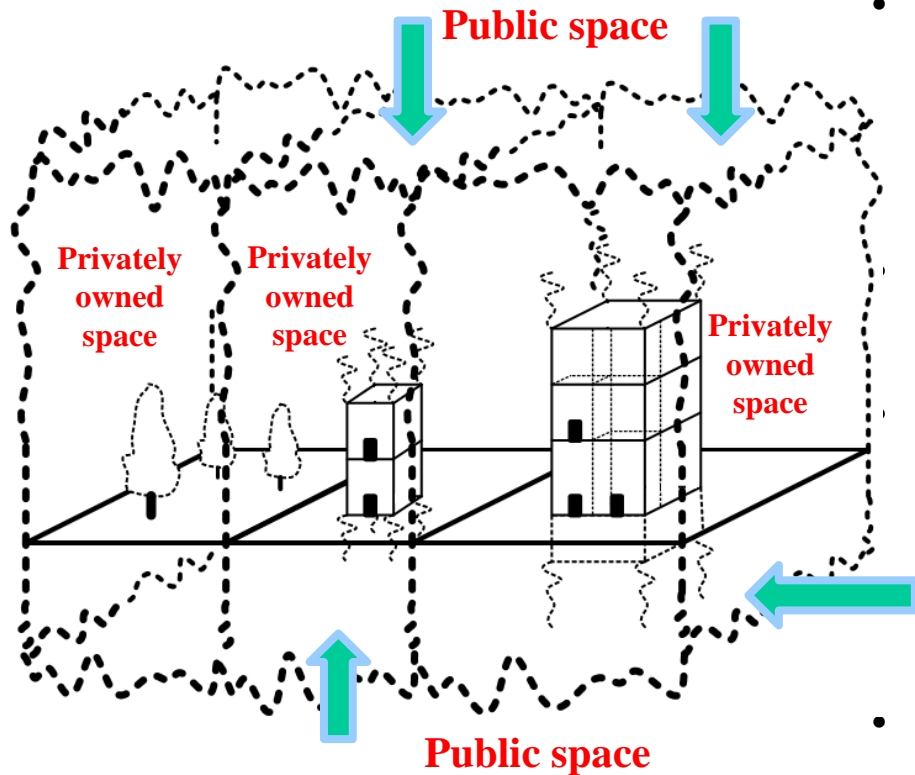
Typical multi-floor building in Athens, Greece

- An extrapolation of the 2D notions in the 3rd dimension presents several interesting characteristics
- Land parcels, naturally, are substituted by 3D volumetric objects
- However, although those objects are defined fairly clearly close to the ground, they have an irregular shape and, more importantly, they become fuzzier as we move upwards or downwards (below the ground) in the vertical dimension.



From 2D to 3D Cadastres

The nature of principal cadastral objects



Schematic representation of typical 3D cadastral objects

- 3D cadastral objects corresponding to land parcels are defined fairly clearly close to the ground and, in the urban areas, within the range of height/depth that construction is permitted

They have unclear (if not undefined) upper or lower bounds

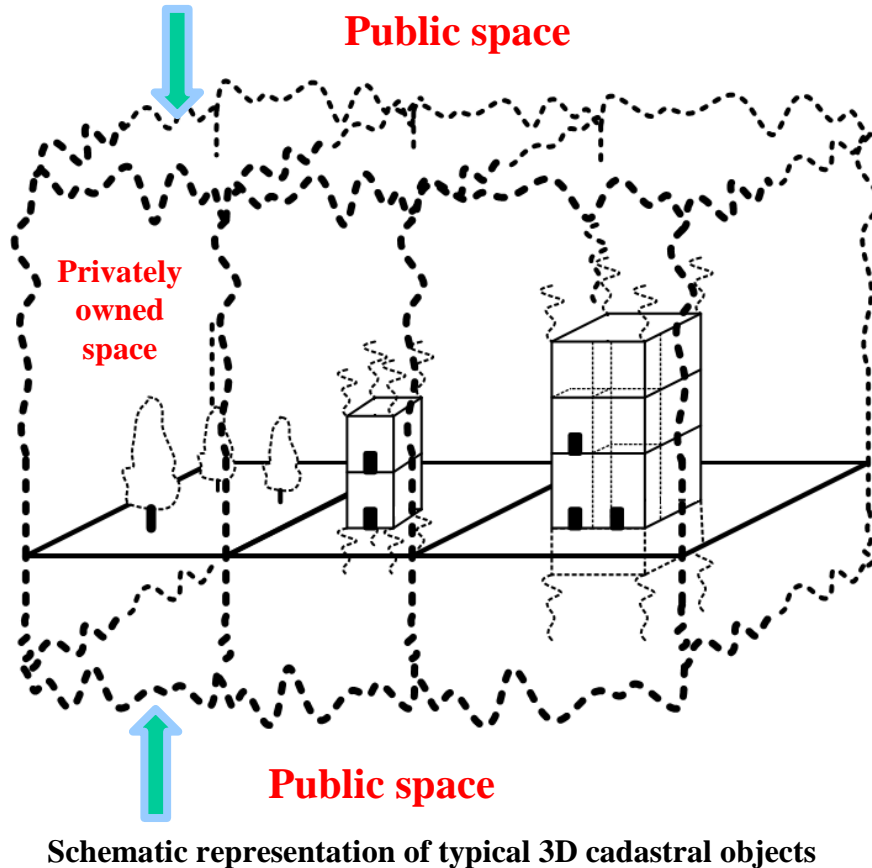
Prisms or other geometrical structures, that are commonly used as approximations in 3D cadastres, are not necessarily an accurate and precise representations of reality (irregular shapes of structures, balconies etc.)

- In order for the 3D cadastres to be put in effect in real situations, there is a need either for the societies to define clearly, along with the side boundaries, the upper and lower bounds of properties or for the 3D cadastre developers to handle the fuzzy areas
- Those bounds may be different from parcel to parcel but they must be defined



From 2D to 3D Cadastres

The nature of principal cadastral objects



- The same arguments apply for rural or other types of non-built land
- The heights or roots of trees, which cannot not be determined *a priori*, are important inhibiting factors in confining with certainty the 3D cadastral objects that represent individual properties.



From 2D to 3D Cadastres

The nature of principal cadastral objects



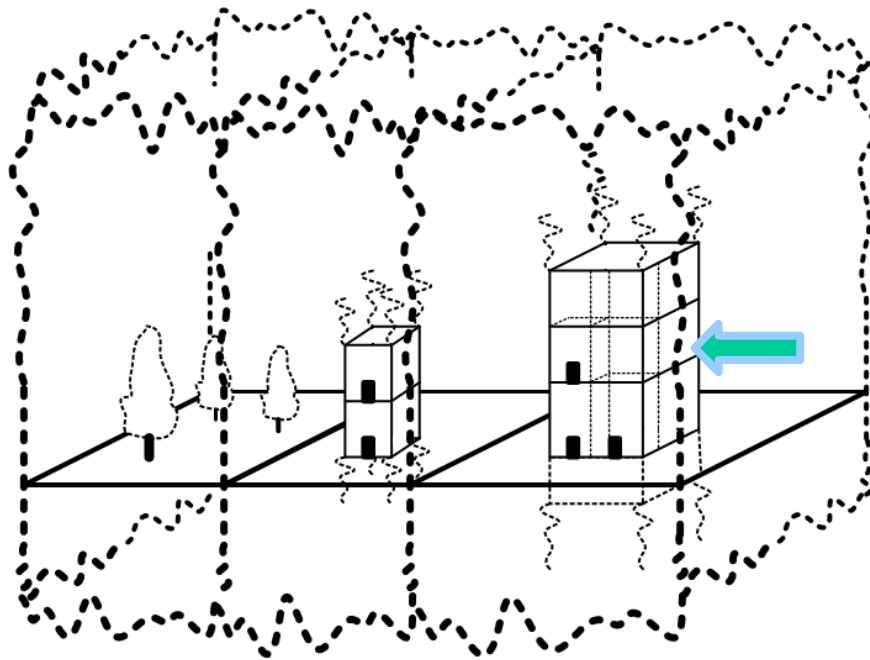
The tallest tree on the Earth. Photo: Michael Nichols/National Geographic

- The same arguments apply for rural or other types of non-built land
- Currently, in the 3D cadastres area there has been little attention to rural or other non-built areas
- Exception to the general rule to use might be the State owned areas where, in addition to the ownership criterion, the intended use should be considered as a criterion in defining the boundaries of the 3D objects that correspond to land parcels. (This definition is analogous to the “special areas” parcels in the 2D paradigm)
- This way an area intended for transportation would be a different cadastral object than an area which is a forest, or shore.



From 2D to 3D Cadastres

The nature of principal cadastral objects



Schematic representation of typical 3D cadastral objects

Ownership of apartments in apartment buildings

- Representation of functional and structural space in 3D. It includes all areas, joint or disjoint, that are within the functioning powers of the owner(s) (e.g. main areas, balconies, storage houses, parkings etc.)

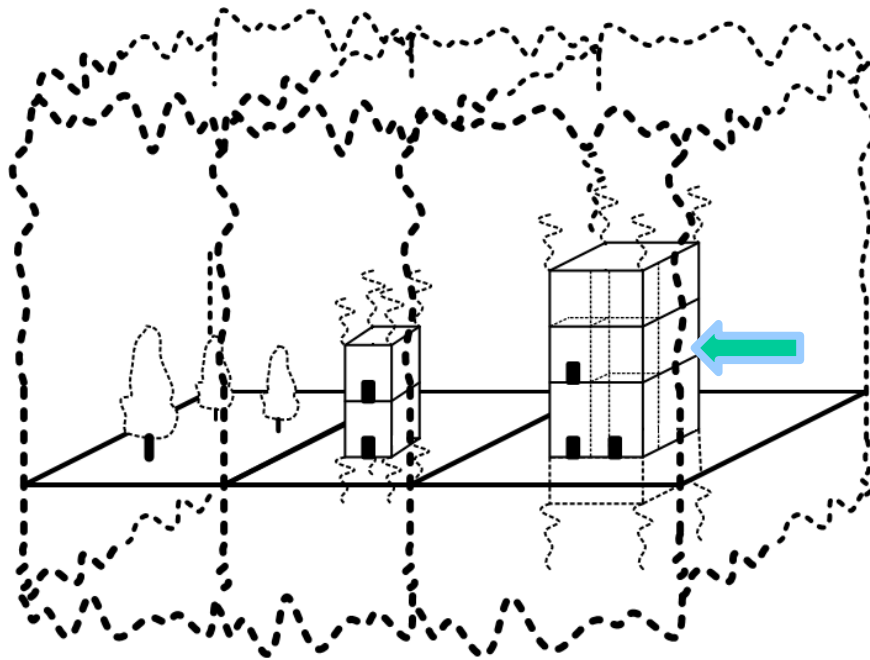
- Such property units, normally, are multi-object units, each of which has a special function (e.g. parking, storage house etc.)

- Objects involved in this case have a much clearer definition, although there are instances and aspects in which the exact volume of the corresponding object is not specified explicitly (parkings, exclusive use areas)



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Schematic representation of typical 3D cadastral objects

Ownership of apartments in apartment buildings

•Of importance to representation are the structural elements of the building

- External and main structure belong to all co-owners of the building
- Walls, and floors separating properties should be subject to ownership by neighbors

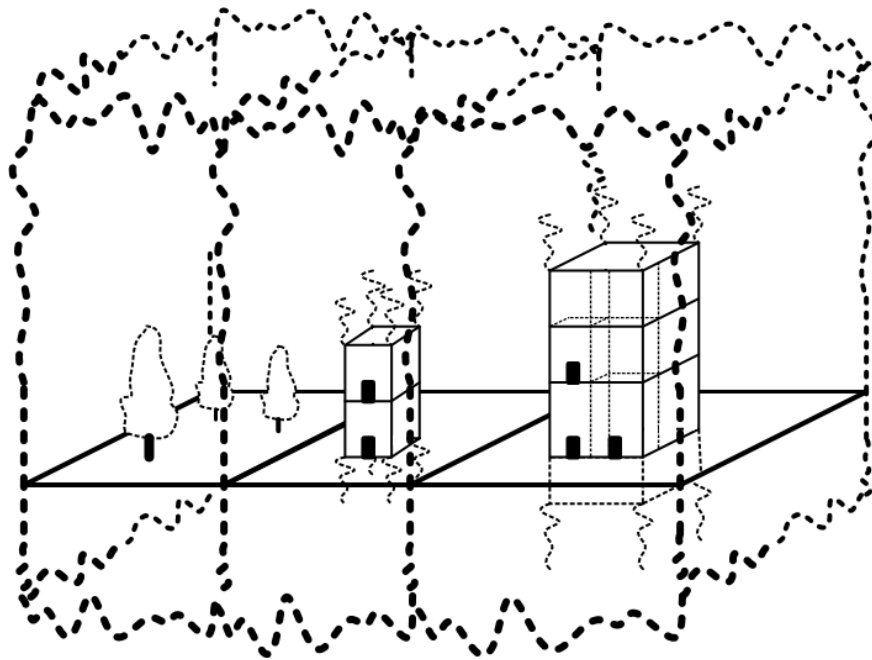
•Also, of importance to representation are the mechanical parkings which have moving parts and, therefore, occupy different space in various times

•Distinction between “shared space” in a building or the land parcel of the building (amenable for use only by the co-owners of the building) and “public space” in general (roads, streets, etc.)



From 2D to 3D Cadastres

Relationships among 3D cadastral objects



Schematic representation of typical 3D cadastral objects

Among the numerous relationships that may be defined among spatial cadastral objects, some of particular interest are:

- **Directional topological relationships.** In the 3D context, regular topological relationships must be restrained and those referring to the vertical dimension should be distinguished from those that refer to the horizontal dimensions. The effects of “above” and “below” relationships are not functionally similar to the “side” relationships.

- **Hierarchically ordered ownership relationships.** Relationships specified among 3D cadastral objects that correspond to parcels are stronger than those that refer to “intra-parcel” objects (e.g. a 3D object that defines an apartment may not violate spatially a property boundary).



Conclusions



“Under-the-ground” (“Hyposkafa”) properties, Santorini, GREECE

(Photo adopted from <http://www.greekarchitects.gr>, Architect's Eye View, June 06, 2014)

- The development of 3D cadasters require refinement of the abstract spatial objects that define ownership and other rights, restrictions or responsibilities (RRRs)

- Of particular importance is the definition and or clarification of the upper and lower boundaries of 3D objects

- Treatment of 3D objects should be uniform and complete. It should cover not only urban areas or complex human structures but rural and other non-built areas, as well.

- Progress in the definition and clarification of cadastral objects and relationships would facilitate greatly the development of robust 3D cadastral software systems that can be put to operation once it is decided so.

