

# **Third Dimension (3D) in Cadastre and Its Integration with 3D GIS in Turkey**

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**Keywords:** 3D Cadastre, 3D legal registration, Over and underground usage rights.

## **SUMMARY**

3D cadastre data used in 3D spatial cadastral informational systems as a main base especially in the countries where cadastral systems completed. This parcel based information systems use the parcel as a main unit and contain property relations.

The Cadastre Law accepted to perform and produce 3D cadastral bases and their legal status In Turkey in 1985. Although the obligation of 3D cadastre studies are described and explained by laws, the studies created in 2D until now. So cadastral bases and maps have not been produced as in third dimension.

All over the world and in Turkey especially in metropolitan areas many big engineering projects carried out to open new areas for public use because of scarcity of vacant land for development. The 3D cadastral bases and data are necessary for using above and under space for constructing engineering structures and objects. In the land registry there are some difficulties to register the ownership and other rights of real estate objects under or above the surface. Especially in our country there are legal problems to register public utilities, underground public garages, metro stations, underground shopping centers etc. Today these problems are solved using the above rights and “upper right” in law by relevant intuitions to negotiate the matters.

In 1990 the project called “TAKBİS” (Register and Cadastre Information System) put into practice by General Directorate of Land Titles and Cadastre (TKGM). The same project has been carried on currently in the Title of Cadastre Information System. In turkey many local governments have started to set up local information systems and during these studies they practice digital cadastre studies. All cadastre works need reliable, current and precision data.

The bases and data have produced in local coordinate systems until now And They have to be transformed to nation systems digital cadastre and also title deed register information needed. The forming digital cadastre bases by the local authorities, the methods of public improvements applications, digitizing from the original maps and coordinate transformation are using. The bases obtained by using these methods have some serious technical and legal problems. Addition to solving all bases problems, there is another problem using 3D data with these bases in all various engineering applications.

Traditionally The cadastre information are defined in 2D. The objects are digitally stored and maintained in spatial information systems. Parcels and objects legal status are registered in

two dimensional systems. Because of growing interest in using space under and above the surface, 3D information becomes increasingly important in registering today's 3D world. Addition to, beside spatial and attribute information of 3D objects, register information and 3D objects digital and video images should be included to system. All these stages could be realized and integrated to information systems with today's new technologies.

To conclude, it is very easy and important to describe the factual situation When 3D data used to confirm the legal status. Therefore a system can be developed to collect, model and visualize 3D data especially concerning objects under and above the surface in relation with the already available data on 2D parcels. With this system supported 3D data and objects The Türkiye's Cadastre will be able to perform its task more efficiently and meet the needs of most of the engineering applications and register the legal status of real estate objects and to provide this information. In this study the concept of 3D information systems and cadastral data are observed in Turkey. Data collection techniques such as digital and video cameras are considered for the management of 3D Cadastral information systems in making correct and sound decisions. As well, control time, work and reliability criterion are evaluated.

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## **1. INTRODUCTION**

All over the world and Turkey public use vacant land for developing is becoming less especially in metropolitan areas. There is no adequate parking space in urban areas. Despite these relations, the urban activities aim public interest increase with the new technologies. Telecommunication, traffic arrangement, transportation, communication etc can be given as examples.

Together with overpopulation, increasing vehicle and pedestrian traffic in last years, putting in use some new transporting facilities like metros, highways, underground stations, railways obligate to construct some new buildings under and above of the surface especially in metropolitan areas to avoid traffic difficulties and provide healthy urban life [Ossko', 2002].

The public services, investors and real estate developers have been trying to solve all these problems with using above and under of the surface. Beside this developments there is another problem coming up is register these properties in the traditional cadastre, maps and land registry. Traditional cadastral maps and legal registry have been created for 2D space. Therefore 3D information becomes increasingly important to define objects in land registration today's 3D world.

Using 3D data in applications, to register properties, property rights of objects in geometrically and legal situation, parcel based 3D information systems should be supported with third dimension, information and 3D data.

Today, urban concept has different meaning with the new technologies. About virtual urban, virtual urban management are mentioned. Therefore urban planning, design and imagination become more important. Seeing the world in three dimensions, having the powerful, superiority and easy-to-use technology, the rapid change of user needs are the main reasons for human being to bring and built the 3D technology and systems in computer environment. 3D geographical information systems used for modeling urban areas in 3D and GIS also used as a main base for these studies in last years. In addition, 3D virtual scenarios have been put in practice [Aydın, 2003].

In this paper, in addition to 3D concept carried out via personel computers with necessary softwares, the necessity of object registration in 3D form to land Registry System includes under and above objects of the surface in Turkey's conditions are discussed and cadastre works evaluated with this concept.

## **2. THE STATIONS IN TURKEY AND CADASTRAL REGISTRATION SYSTEM**

After the Second World War, the needs of agricultural products and definition of agricultural lands increased the necessity for the cadastral surveys and thus the cadastre survey of the whole country initiated in the early years of 1950's. In the mean time, techniques and legal changes have been made in cadastre law and cadastral surveys continued. Up to now % 98 of urban cadastre, % 81 of district cadastre and % 66 of rural areas cadastre have been completed in Turkey.

The new technologies and advantages are used in works increasing the workloads. The digital cadastre age started after GIS development and cadastre data could only be used in digital form. Some changes made in the cadastre law to use these advantages. In 1990 the project TAKBİS (Register and Cadastre Information System) put into practice by General Directorate of Land Titles and Cadastre (TKGM). The same project has been carried on currently in the title of Cadastre Information System. In Turkey many local governments have started to set up local urban information systems and during these studies they practice digital cadastre studies which is inevitable [Demir et al, 2003].

Until now, legal status of parcel boundaries and registration are defined in two dimensional space. For this reason some serious problems occurred to register under and above objects and registration of their property right and other rights. This problem especially seen frequently in İstanbul, Ankara, Konya etc.

During this research, it is determined that the condominium law is used to register under and above objects in Turkey. Similar problems have been appeared in provinces and districts. Problems have been sorted out by directives of General Directorate of Land Titles and Cadastre (TKGM) with correspondence.

## **3. THE LEGAL CONTEXT**

In this part of this research, some information given about the property rights of under and above objects in Turkey.

According to 998 section of Civil Code, following things are registered to title deeds.

- Land
- Individual and permanent rights establishment on properties (Property Rights, right of access, rights of mortgage etc.)
- Mines

The properties that are nor registered as individual possessions (e.g. motorways, bridges, squares, etc ) may not be recorded on the title deeds log [Tüdeş and Bıyık, 2001].

According to law individual and permanent rights are in property characteristic and have no material value like lands. These rights are recorded as individual and permanent rights to title deeds on different page and related to properties built on the land. These rights can be

transferred to another person, inheritors and every kind personal and real rights are built on them.

Individual and permanent rights are exception of completeness piece principle. Because they are accepted as different owner real estate in addition to situation over and under of properties related. These rights are upper and source rights.

Upper right is defined as; to build buildings on a land which the property right of the land belongs to someone else (Turkish Civil Law / 826). According to law to have the rights of properties that means have the all the rights like use of under and above rights etc. In response 652. section of law says; under and above rights of any properties can be belonged to someone else with registration to title deeds.

Upper right is a right of access can be established in juristic or real person's favor as periodical or not. These rights can be transferred to another person, inheritors and every kind personal and real rights are established on them [Karagöz, 1995].

In 1960 The Underground water law accepted. 167. Section of this law says; Underground water is in the possession of the government. As required by law to use properties rights does not mean to use properties underground rights [Şentüfekçi, 2003].

Until now, the legal bases of 3D cadastre works given. It is understood the legal part of 3D cadastre has been solved by right of access establishment. But there are many problems are faced in practice. Today these problems are solved using the above rights and upper right in law by relevant institutions to negotiate the matters. So the legal gaps can be easily found in registration of third dimension. Some example of corresponds given below. In correspondence with TKGM and its organizations,

Place: Rize / TURKEY, Çarşı district, 34 Block, 125 parcel: a shop built under parcel 125. The land include the shop underneath will be registered as a road attribute to Rize Municipality and legal documents will be arranged in the name of shops owners according to civil law section 652 or 751. Also upper right will be established and this procedure will be done in direction of notice 1508 (Number: 1001-1525/9-1331, Subject: Registration, Date: 5 April 1991).

Place: Kastamonu / TURKEY, Hepkebirler district, Mutaflar street: Building some shops under mutaflar street by Mutaflar municipality and the roads are belong to municipality in municipality borders it is possible to register the roads upper the shops in the name of Hepkebirler municipality and shops can be registered as individual and permanent rights according to civil law section 826. (Number: 1001-1525/4-1684, Subject: Access right, Date: 13 April 1990)

More complicated examples can be added the corresponds above. It is appears that objects build under and above surface include more than one parcels.

## 4. THE LAND OBJECTS CONCERNING 3D CADASTRE IN TURKEY

Factual situations (situations occurring in the real world), for which it has appeared that the current 2D system is not able to represent the legal status of the situation in the most efficient manner [Stoter and Zeuberger, 2002]. In this section some information will be given about 3D cadastre subjects and relevant to objects live underground stations, multilevel underground car parks etc. unseen in 2D digital photogrammetric maps and can be present in 3D geographical Information Systems.

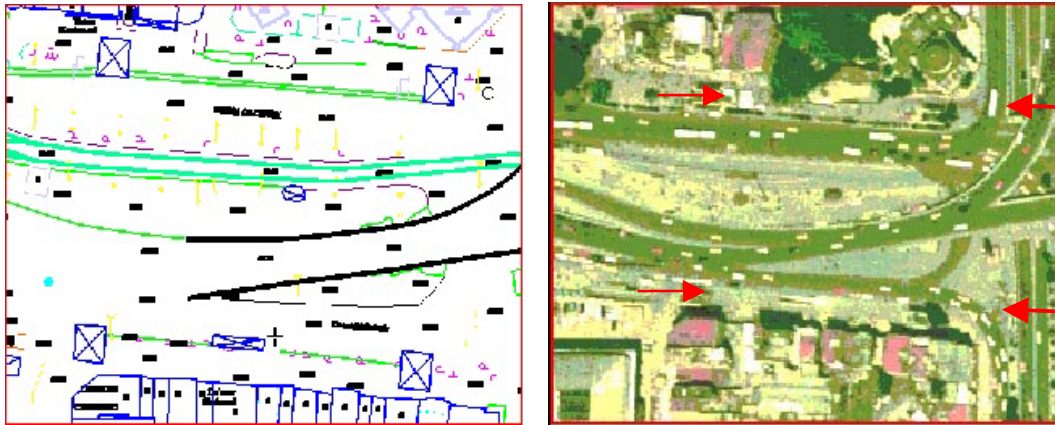
- constructions on top of each other (an underground parking place),
- super- and subterranean infrastructure (a tram above the surface, tunnel, metro), apartments,
- (the location and ownership of) cables and pipes,
- historical monuments,

### 4.1. Underground Shopping Centers

Underground shops are the objects unseen on air photographs. They left under the surface when photographs digitized. These shops used as commerce and relax center and serve wide common masses.

These objects can be presented in 3D GIS using digital and video camera images include geometric and attribute data. Especially video cameras are very useful to film these objects then transfer to system. With GIS and camera systems moving images of underground shops can be presented in GIS. Time to time new images can be added to update and riched the system.

Aksaray square underground shopping centre look like a district with its shop management, workers, work shops, infrastructures etc. The underground shop shelters 1 pharmacy, 1 optician, 1 perfumery, 1 jeweler, 1 sweet shop, 1 WC, 1 tea house, 1 change office and 134 work shops. These work shops has area between 16m<sup>2</sup> and 219m<sup>2</sup>. In this shop 1 Manager, 1 secretary, 1 technician, 10 security officials and 3 cleaning officials, total 15 people are in duty.

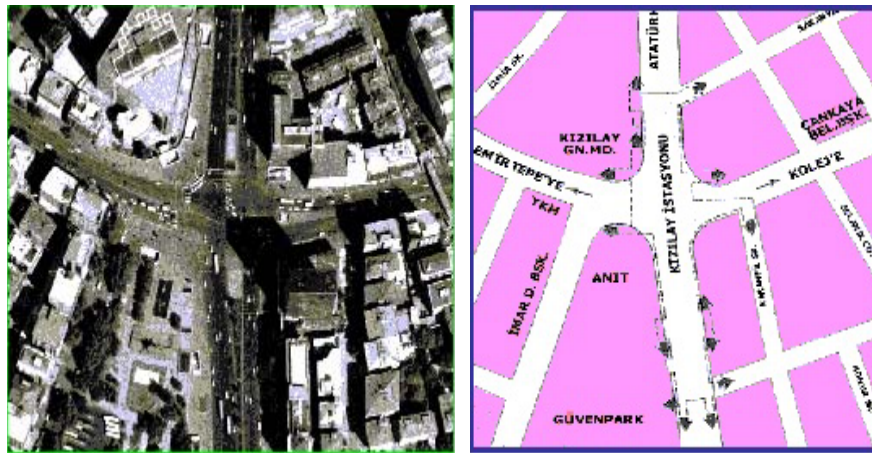


**Figure 1.** The Aksaray square underground shop in İstanbul and it's ortophoto

## 4.2. Underground Stations

Undergrounds are one of the important components for daily life. Especially part of underground stops sheltered a lot of serving, shopping and resting structures. They have their own settlement plans, security systems, management systems etc. Briefly they are small model of the cities and unseen on the maps. Geometric and attribute data belong to these objects can be extracted from their video and digital camera images and then transferred to data bases.

The capital Ankara Kızılay underground stations look like small units of the city. It has a large data density for planning a GIS project and is a very good example of using the underground parcels for 3D cadastre. As mention above these objects can be present in 2D and 3D forms in system.



**Figure 2.** Kızılay square, maps and ortophoto



### 4.3 Underground Parking Spaces

Underground parking lots are frequently used in the urbanization process. In Turkey especially the lower level of buildings is made use of as an underground parking space. These areas are sometimes larger than the building area. Because these areas are not marked on maps, problems occurred at the project and application stages. During infrastructure works faulty excavations may be carried out and problems occur. City planners also have some problems due to the lack of information about these areas. Another problem is the underground canals. The utilities below these canals and other underground areas may overlap due to lack of up-to-date information. Underground parking spaces can be located in the GIS environment.



Figure 3. Underground parking place of Aksaray Square, İstanbul

Underground parking place of Aksaray Square has three entry-exit and the capacity of 350-400 cars.

### 4.4 Pedestrian Subways

Pedestrian subways have the same characteristics as the objects mentioned above. They serve to daily life with their commercial structures and pedestrian density.



Figure 4. Haşim İşcan Subway, Saraçhane square, İstanbul



Haşim İşcan Subway is one of the important transport center and main place for toy sector [Aydın, 2003].

All these situations have in common that the third dimension is relevant in confirming the legal status of the real estate objects concerned. Apart from apartments, there are no formal rules for registering the legal status, the (2D or 3D) geographical location or the extent of these 3D objects. Although this would give insight in what is situated under and above the surface. This insight would support the definition of rights concerning real estate objects under and above the surface.

Today legal statute of properties solved in 2D therefore A horizontal division in (the legal status of) property is made by the establishment and registration of rights and limited rights on the parcels.

- right of building, the right to erect buildings under, on or above land owned by a third party
- right of long lease, a third party gets the right to use the parcel (including space under and above the parcel) as if he were the owner
- right of easement, a third party gets the right to use the parcel for a certain limited purpose
- right to an apartment or condominium right
- joint ownership, i.e. the shared ownership of an immovable good from which all shared owners of the parcels benefit, for example walls, roads, parking places, swimming pools etc.

A factual 3D object itself cannot be defined as a cadastral object in the cadastral map and cannot be used as a base for registration. In the current cadastral registration system (with regard to landed properties) a cadastral object is a real-estate object being a complete parcel, part of a parcel or a condominium right.

In order to all mentioned above the existence of 3D parcels creates some other problems that have to be solved. Some of them will be given

- with the existence of 3D parcels, the meaning of the right of property changes; the adjustment of the definition of property will take considerable time, since this requires a major change in legislation;
- Should the right of property of a 2D parcel be defined as a column of space less the possible existence of a 3D parcel above or under the surface?
- are the owners of ‘surface’ parcels obliged to tolerate the definition of a 3D parcel above or under their parcel (they loose an amount of ‘space’ of their property);
- Juridical relations between parcels on top of each other should be clearly defined like access to the concerning parcels via other parcels and the protection (avoiding damage) of the real estate objects involved (right of easement in 3Dspace?). [Stoter and zeverberge, 2002]. This concept is available in upper right in Turkey.

When all needs, problems and imaginations taken into consideration, what kind of object definitions will be made and 3D data needed for cadastre Information system are another problems. We have 2D bases and 3D information requirements are inevitable. One of the most important thing is data management. Data relations between 2D-2D and 3D- 3D data in data tables and legal limitations are the other subjects has been waited to be solved. To solve all these problems and pass the steps, a spatial cadastre information system includes 2D and 3D data shared and used together are necessary.

## **5. ASSESSMENT AT THE APPLICATION STAGE**

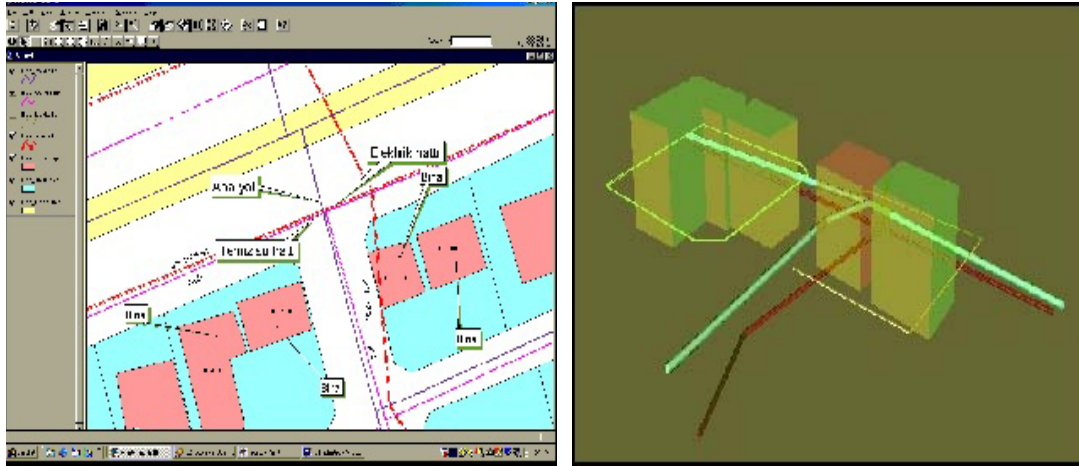
In this stage of study it is stressed on gaining of using 3D models in general and cadastre works. 3D models are evaluated shortly and their convenient using explained with studies.

Encouragement for 3D-gis comes from advances in technology and evolving user needs. The demand for spatial information is most pressing in urban areas. Increasingly complex analysis tasks demand 3D topologically structured data. With digital technology we do not have to rely anymore solely on graphic expression of 3D reality and when need we can generate photographs with great flexibility and speed [Tempfli, 1998].

The demand for present the world more realistic, 3D digital models becomes important solutions. With these solutions, urban areas can be described and presented more efficiently, planning, controlling and taking decisions made easily and profitable. Adding video and digital camera images provides easiness to produce more realistic models for real world [Aydm, 2003].

Photo textured tree dimensional models are easy for people to understand quickly. They can recognize specific elements and orient their view in terms of spatial position and scale. Unless people have had a lot of experience reading plans, the traditional products of planning and GIS can be undecipherable or confusing to non-experts especially solving cadastre and urban problems solving. This can leave people with the wrong impression of a design's positive and negative aspects. Photo textured models serve as an excellent base to relate plan details and other information [Danahy, 1999].

After giving the advantages of using 3D models, some studies and works explained below.



**Figure 5.** 2D and 3D presentation

On the left of Figure 5 shows GIS applications in a district within municipality includes parcels, electricity lines, clean water lines, main ways, building coverages. Simple 3D modeling of the same area given on the right. Presentation of infrastructure facilities as 3D in 3D cadastre information systems like telecommunication lines, electricity lines etc;

- Definition of Cadastre parcels effected underground infrastructure facilities
- Using this unseen objects on maps in 3D forms and making all necessary planning like revision underground infrastructure facilities
- By determining objects locations make a decision that which objects is under or above the others. Therefore decisions will be take about objects distance, depth, mutually locations and all these values easily can be taken on screen.
- 3D digital cadastre information systems can be supported by 3D solid models an video and digital camera images so very similar models to real world can be obtained and visualized.

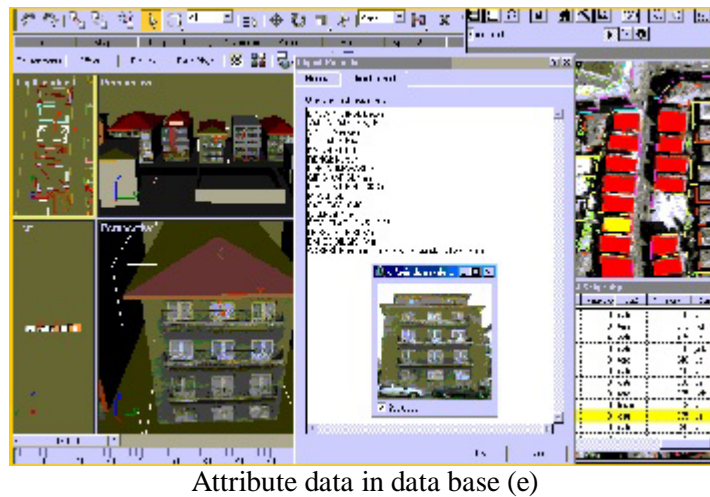
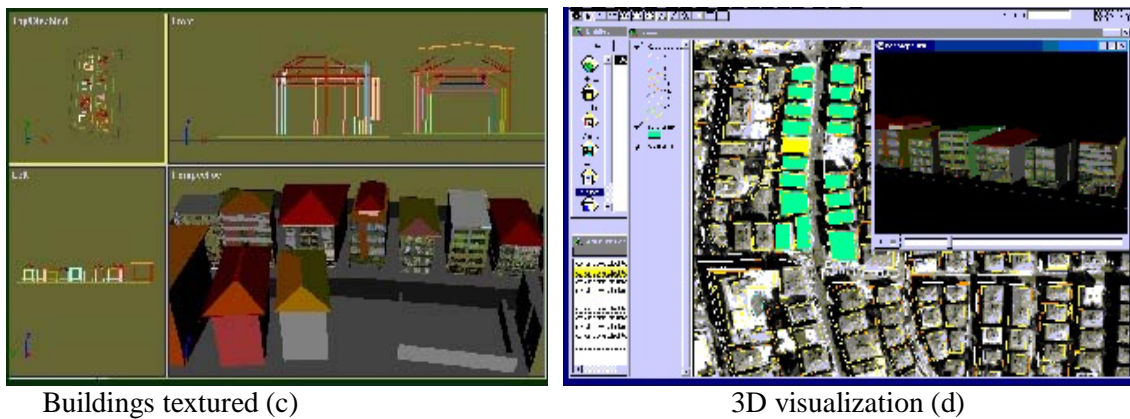
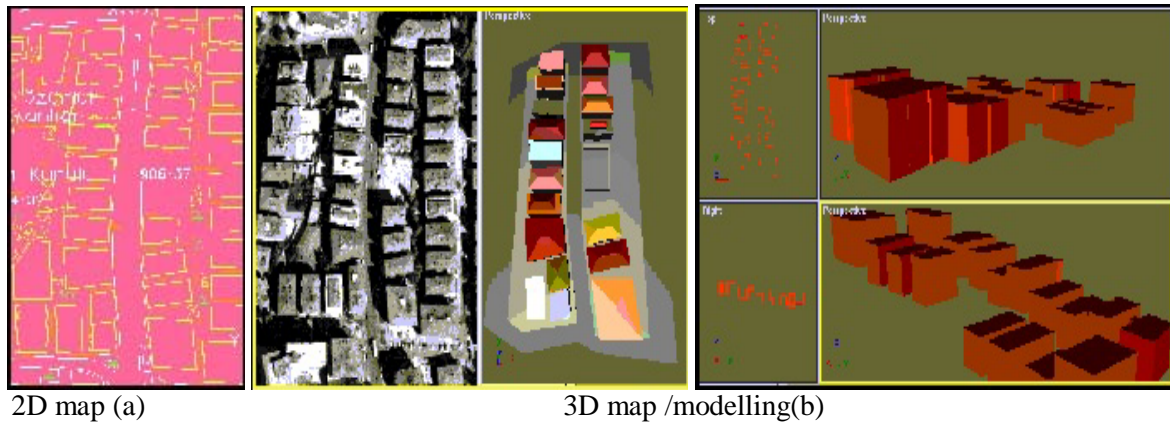
3D modeling formed for a street called Bankacılar in Kavaklıdere district in Ankara shown in Figure 6.

2D digital map (a), 3D digital photogrammetric map (b), buildings (solid objects) dressed with street based images (c), application area visualized with video images (d) and attribute data belong to under and above structures in data base (e).

Modeling by using urban's 3D objects;

- Pilot areas can perspectivevely perceived from any direction as 3D
- All necessary information can be collected, analyzed and queried for under and above 3D objects like buildings, water lines, telecommunication lines etc.
- Using cadastre, present and imar based imar and cadastre works can be realized in 3D thus it is assisted in solving technical, planning and legal problems in the stage of establishing under and above structures.

- After forming these 3D bases, traffic, environment, landscape and necessary arrangements can be made easily.



**Figure 6.** All process, (a),(b),(c),(d),(e)

- All 3D information can be obtained related to application areas without going. This is very important for metropolitans. Because underground parking spaces, sewer lines,

water systems not seen in digital maps. Every type of planning for urban areas can be made easily with these geometric and attribute information [Aydın, 2003].

## 6. CONCLUSIONS

Institutions and organizations have been carrying out their works rapidly about surveying properties, determining their legal status and obtaining the necessary information relating to individuals. All over the world and in this country specialists make the subject of using under and above surface, projects and works a current issue. Today it is necessary to define and register these objects both technically and legally. So far in Turkey legal rights concerning these objects have been realized in 2D.

In the last ten years a lot of reforms have been made to improve data quality. Now 3D representation and object definition are very easy to be formed in computer environment even with personal computers. Therefore conforming the legal status of under and above properties in 3D cadastre is very important and it is on the agenda these days to meet the needs the institutions.

Developing an understanding concept to present and solve their legal status these objects in more realistic 3D forms is one of the main important points. If the object is in discussion in 3D form it is necessary to describe them in 3D environment. 2D systems and bases have served to cadastral works for a long time. Adding to 3D data to this systems a 3D parcel based cadastre information system can be developed to collect necessary information concerning objects under and above the surface then all queries, presentation and also 3D object definitions can be made in data bases.

Technical part of 3D cadastre works have been done as 2D and its legal part has been tried to solve with sharing rights in Turkey. The legal frame work is not quite clear about 3D registration. Therefore an active system with application of 3D works, cadastre organizations perform their tasks more efficiently and effectively.

In this study, the needs and requests for 3D cadastre were taken into consideration and existing situations, problems, solution proposals were given especially for objects under and above the surface. A wide-ranging search of relevant publications was made about the subject and studies in all over the world.

At the beginning of the study, we had some reservations concerning the legal context. At the further stages we quite enjoyed studying this kind of subject and in the end we decided that all problems can be solved from both the technical and legal points of view.

We have concluded that we will meet a lot of problems about the subjects concerning under and above surface in next few days in Turkey and will continue studying specific examples of technical and legal deadlocks about 3D cadastre. Also the establishment of title deeds in 3D and definition a brand new 3D title deed studies will be central to our following studies.

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orthogonal method” in september 2000. His research interests are cadastre and cadastre information system.

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