STATE OF THE ART OF 2D CADASTRE AND REFLECTION ON A FUTURE 3D CADASTRE CASE OF MOROCCO

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ABSTRACT

Nowadays, the representation of 3D objects takes more and more importance in the treatment of geographic information. Geographic Information Systems (GIS) can integrate three-dimensional data in the fields of urban planning, simulation of future projects and integration into the landscape, etc. Consequently, the 3D data has become an interactive data of great importance. In the Moroccan cadastre, information is represented using only 2D topographical plans. These plans do not allow a faithful presentation of reality, especially in the case of buildings with complex geometry, containing apartments belonging to several owners. The objective of this paper is to present the state of the art of the Moroccan cadastre and make a reflection on a 3D cadastre based on previous international experiences, while maintaining the positive aspects of 2D cadastre. In the Moroccan context, any building, whose ownership is split between several owners in batches, sharing common elements, constitute what is called co-ownership (coproperty). A co-ownership is managed using the 2D topographic plan, but this representation does not allow a comprehensive view of the entire property. In addition, the co-ownership cannot represent 3D rights, restrictions and responsibilities related to the ownership because the vertical information exists only in vertical sections. For this reason, it is encouraged to think about a 3D cadastre which should represent both the reality and the legal value. Based on international experiences, in the case of Morocco it is recommended to adopt a hybrid cadastre for the following areas: Urban areas with high density population and where there exists, multi-rise buildings; In areas where there is an overlay between public property such as roads, bridges, monuments, high buildings and private properties. However, the application of a 3D cadastre in Morocco is subject to several constraints. Among which we can mention: a) Technical and human resources constraints b) Legislative constraints c) Scientific Constraints.

Key words: cadastre, 2D, 3D, ownership, co-ownership

INTRODUCTION

Since the early 90s, the need for 3D information has become important for the users of geographic information. This three-dimensional information demand is due to the evolution of data acquisition techniques and to the evolution of software products supporting the third dimension. Hence, 3D has known a great success and rapid development; consequently this rapid progress has made the 2D representation insufficient in several domains.

In the Moroccan cadastre, information is represented using only 2D topographical plans. These plans do not allow a faithful presentation of reality, especially in the case of buildings with complex geometry containing apartments belonging to several owners.

The objective of this paper is to present the state of the art of the Moroccan cadastre and make a reflection on a 3D cadastre based on previous international experiences, while maintaining the positive aspects of 2D cadastre.

BASIC CONCEPTS ON THREE DIMENSION REPRESENTATION (3D)

At the beginning of this article, it is essential to review some basic concepts on 3D in literature. Depending on the context, the terms "3D dimension" and “3D shape” can get different definitions.

The 3D shape is defined by ESRI as follows: " A three-dimensional shape is : A point, line, or polygon that stores x, y, and z coordinates as part of its geometry. A point has one set of z coordinates; lines and polygons have z coordinates for each vertex" (Larrivée et al., 2002).

In 3D literature, object dimensions are related to the number of axes (or coordinates) required for positioning the objects with respect to each other’s. Thus, spatial dimensions of an object represent the space occupied by the object in the three directions of measurement that are length, width and height. We talk about linear object of one dimension (1D), a surface object of two-dimension (2D) and a volumetric object of three-dimension (3D), that is length, width and height 3D (Larrivée et al., 2002).

THE EVOLUTION OF 3D CONCEPTS

The development of 3D has evolved rapidly during the last years. The first step towards the third dimension was to add to each pair of coordinates (X, Y) a Z altitude recorded as a simple attribute. The main limitation of this type of approach is to allow only one Z value anywhere in the represented geographical area (Ramos, 2003). These systems have been designated by the 2.5D solution.

After that there was the 2.75D solution, which provides templates to store two different altitudes (minimum altitude and maximum altitude) for the same pair of (X, Y) coordinates. However, this solution was inadequate in the case of the representation of complex objects (Ramos, 2003).

Then, with the evolution of computer tools, researches on the concepts of 3D have increased. There were several developments of solutions including guidelines to 3D for the representation of geospatial data. An increasing need for 3D was observed in several areas, such as in urban planning, land management and cadastre.

USEFULNESS OF 3D CADASTRE

Considering the fast world population expansion, the use of land became of great necessity, and such necessity requires precise and reliable description of land ownership. Previously, a description of the property rights in two dimensions was sufficient to provide clear information on the legal status of real estate. Today, however, because of multiple use of space, with laminated property rights in the basement and ground floors, the 2D traditional cadastre became very limited, and will no longer be able to accurately describe the spatial information rights in the third dimension (Adrien, 2010).

For instance, in the case of a road, a bridge and a building one over the other, all with different owners, the 2D cadastre is no longer able to give a complete and sufficient description of the rights. Consequently, a 3D cadastre becomes indispensable.

CATEGORIES OF 3D CADASTRE

A 3D cadastre provides information beyond the typical two dimension data. It can be used to ensure the registration of property rights under and above the floor. Land use and groundwater can be described and analyzed as well (Papaefthymiou et al., 2004). Paulsson (2007) defined the 3D property as follows: "It is a property that is legally defined both vertically and horizontally."

Adrien (2010) in his research identifies three main categories of the 3D cadastre. In the following paragraphs, we will give a brief description of each category.

The 2D Cadastre with 3D Markers: This type of cadastre keeps the 2D parcels by adding labels on a digital map to indicate the existence of 3D information. These labels are used to mention to the user corresponding references to some documents containing 3D information such as acts or plans. The owner is asked to carry out investigations to find additional information in the land register.

This type of land registry, however, does not allow a good understanding of the 3D situations, as it gives only a 2D representation of land properties, hence only one parcel can be displayed at a time.

The Hybrid Cadastre: In a hybrid cadastre, it is possible to represent in three dimensions the infrastructures and the attached rights as well. This type of cadastre enrolls the physical 3D objects like buildings or infrastructures that may be above, on or below the surface of a parcel, for example, a tunnel that crosses several parcels. In this case the object is registered with a spatial description with plans and sections.

In this kind of cadastre, the 3D data exists in various forms:

- As a text: for example, a reference number such as the complementary map's number, which itself refers to other maps or 3D models.
- As volumes showing the existence of infrastructures such as buildings or tunnels.
- As 3D drawings: 3D models representing object rights.

The Pure 3D Cadastre: This kind of cadastre contains only volumetric parcels without holes or overlaps. Property rights are defined and attached to volumetric 3D parcels.

OVERVIEW OF THE MOROCCAN 2D CADASTRE

The cadastre permits to have all information concerning the quality of owners, the properties, and the elements of assessment of goods. Therefore the cadastre provides the following data: information on owners and their land properties, information about the rights and charges, and any technical data on the parcels and their geographical repartition.

In Morocco, the cadastre is the basis for land titling and land registration. It includes geometric description of land parcels and land register so as to provide security of tenure. The basic elements of 2D Moroccan cadastre are cadastral maps, cadastral plans, Titles, and requisitions.

Concerning buildings, the dimensional information is provided by what is known as the co-ownership (co-properties). In a co-ownership, apartments of a building are owned by several people, each one has his rating share, and all people are sharing out common areas within the building.

The status of a co-ownership is governed by texts of the Moroccan law setting for each owner the rights of his part as well as the public facilities and services. In such case, a building is divided into parts: private and public. Each owner holds one or more apartments, on which he has exclusive rights of ownership with certain restrictions such as the requirements to respect the framework collective life and the requirements for the management and maintenance of collective parts (Loi 18-00).

THE INSUFFICIENCIES OF THE CO-OWNERSHIP IN MOROCCAN 2D CADASTRE

The information about co-ownership is described by 2D topographical plans, which means that we cannot know what is above and what is below a floor. In addition, these 2D plans do not allow a global view of the entire property. Therefore, it is impossible to know the vertical extent of servitudes (figures 1 & 2).

Similarly, we cannot consult several apartments at a time, as it is necessary to manually search the title in the archive because of the absence of an automatic link. Therefore, it is difficult to represent all the parts constituting a co-ownership using a cadastral plan.

All these difficulties make it necessary for the managers of the Moroccan cadastre to think about a solution to enable the representation of the physical reality. A cadastre that would allow owners to know precisely what element crosses their properties taking into account the legal values.

THE ADMINISTRATION RESPONSIBLE FOR THE CADASTRE IN MOROCCO

In Morocco, the main administration responsible for the management of all cadastral operations is The National Agency of Land registration, Cadastre and Cartography (ANCFCC). It was established by law No. 58-00 (Dahir No. 1-02-125 of 13 June 2002). It carries out the establishment and preservation of all geodetic infrastructures in Morocco (geodetic network, boundary, leveling network, geoid ...), and all operations concerning land registration, cadastral operations and mapping.

ANCFCC is a public organism responsible for land registration and land titling. It is structured in several Directions, Departments and Services around the kingdom. The Direction of cadastre conducts all technical operations related to cadastre through several exterior services. While the Direction of land registration conducts juridical operations of land registration and land inventory. On the other hand, the Direction of cartography assumes the responsibility of horizontal and vertical geodetic networks and mapping as well.

In the following we present an overall of the achievements of this agency since 1915 (ANCFCC, 2013):

- In land registration and cadastre

- 4,004,363 established land titles.
- 9,911,615 hectares covered by registration.
- 9,911,615 ha bounded and surveyed.

• In the field of Cartography
  - 100% of the country covered by mapping at scales of 1/100000 and 1/250000.
  - 44% of the country covered by mapping at scale 1/50000.
  - 81% of developing areas requiring large-scale mapping, covered by maps at scale 1/25000.
  - 82 maps established for big cities.
  - 40 000 geodetic points, materialized by signals and surveyed
  - 8968 benchmarks of precise leveling established covering 13,400 Km.
  - 15 permanent GPS stations.

REFLECTION ON A FUTURE 3D CADASTRE IN MOROCCO

In this reflection, it is suggested to establish 3D cadastre only in the situation where 2D is not able to respond to some queries such as for the following cases (Benijjane & En-nassiry, 2011) :

- For a building containing several apartments, these apartments belong to several owners that share common parts within the building.
- In the case a home is built upon a public road.
- In the case some companies need to know their rights on the use of tunnels.

In order to preserve the existing data, and exploit the benefits of 2D cadastre, we suggest moving gradually from 2D to a 3D cadastre.

For the Moroccan case, there is no need to represent all the properties in 3D, as it depends on the size, the type and the nature of the property to be described (parcel with constructions, home with one or several levels, buildings,...).

Concepts About Future 3D Cadastre Components

In order to conserve the functioning of the existing Moroccan legislation, land registration and cadastre, it is recommended that the parcel should remain the basic element of the registration, and that the 2D parcels should be kept at the medium term.

The public domain rights can be represented in 3D, like the rights of the public domain on private property such as runways, trails, drainage and irrigation canals.

Servitudes established for public benefits and regulated by the law, can be represented by 3D.

In the case of co-ownership, a 3D cadastre will facilitate understanding the components of the property and will allow users and professionals to understand and visualize common areas and private parts of any building.

In the case of urban areas: It is recommended to use the 3D representation in the urban areas where the geographical space is not spacious, constraining the government to construct complex buildings with several floors. In this type of areas there is a large number of properties. Apartments are characterized by small areas and are grouped together on condensed areas with high population density. In some cases we can also find overlays between public properties such as roads, bridges, buildings, and private properties.

In the case of rural areas: Rural areas are characterized by scattered parcels and habitats. High constructions are absent, overlays don't exist and private ownership is dominant. In this case, a 2D representation is satisfactory because the third dimension necessitates additional financial resources.

Basic Strategies To Move To 3D Cadastre

The first step is to make a 3D support for areas with high buildings. This is the case in the big towns such as the city of Rabat (for example the districts of Agdal and Ryad), the city of Casablanca metropolis, the cities of Tangier, Marrakech, Fès and Agadir. In these towns, the existing 2D database can be used and completed by 3D data.

In order to meet the needs of professionals and public sector as well, it is very useful to provide users with the information on the extent of land ownership and the rights attached to it. So as to accomplish this task, it is suggested that if 3D cadastre is to be adopted in Morocco, it must provide proof of 3D property and the rights encumbering the ownership.

CONCLUSION

In this paper, we have discussed some aspects of 3D concepts. Firstly, we have introduced the state of the art of 3D concepts. Secondly, we have presented an overview of 2D cadastre in Morocco. Finally, we have described some concepts of a future 3D cadastre in Morocco.

Nowadays the need for a 3D cadastre has increased especially for urban areas with the development of multipart constructions. Unfortunately, the implementation of a 3D cadastre in Morocco is subject to several constraints such as technical, legislative, scientific, and human and material resources constraints.

Technical constraints: It is needed to pursue developments in 3D acquisition techniques (in the domain of digital photogrammetry, 3D laser scanning, GNSS ...). Regarding data processing, it will be necessary to establish an adequate 3D platform for 3D objects (complex buildings, overlaid properties) and a database which supports the third Dimension.

Legal constraints are related to problems concerning the registration of 3D property. The legal concepts should be developed in parallel with the technical aspects.

Scientifically: a great effort should be made to clarify to professionals and managers the advantages and qualities of 3D representation.

Concerning material resources constraints: the relevant departments and professionals should provide adequate scientific equipment (hardware, processors, 3D cards ...), and follow the evolution of software products supporting the third dimension. Additionally, human resources do need some training to understand 3D technology and its application to the Moroccan cadastre.

Finally, limited budgets can also obstruct the adoption of 3D representation; a great effort must be made with decision makers to convince them to adhere to the adoption of 3D technology in the Moroccan cadastre. All these constraints constitute a major obstacle to developing and moving to a 3D cadastre.

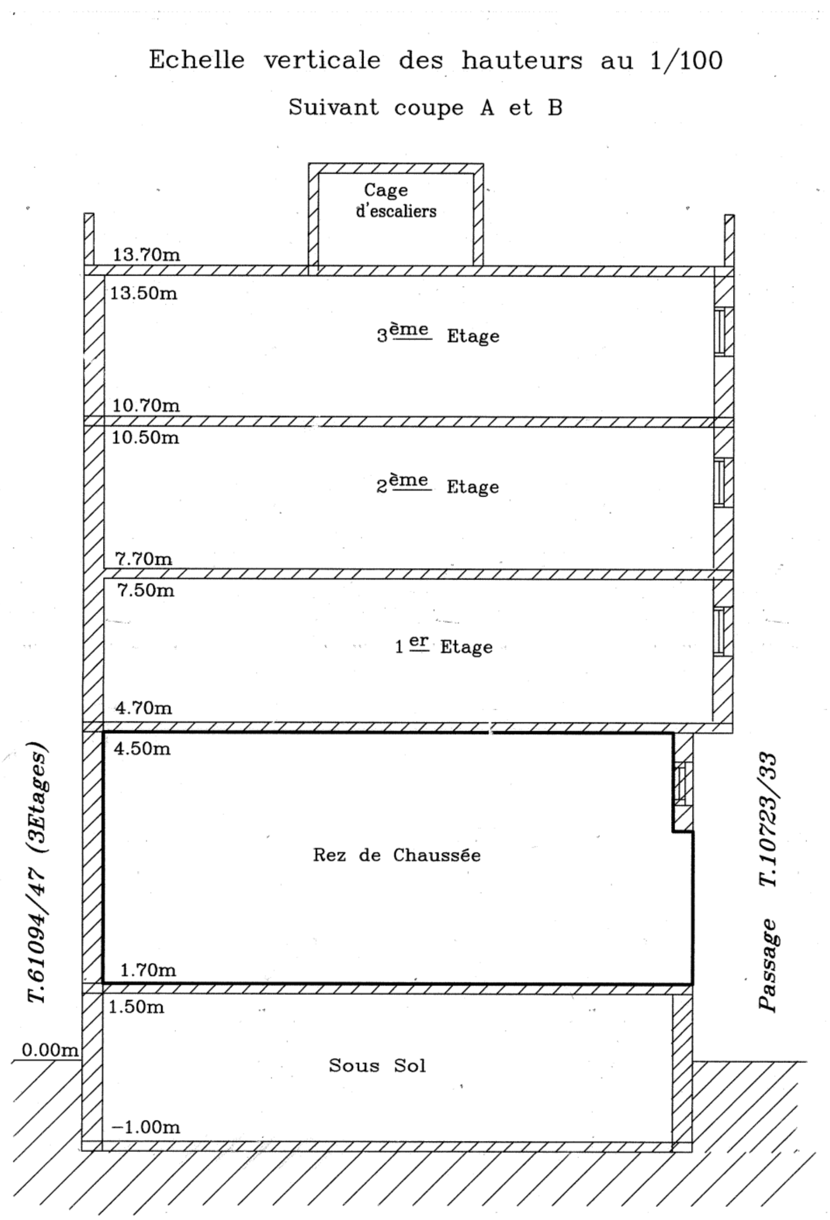

Fig. 1. Example of a co-ownership cadastral plan (vertical sections)

Fig. 2. Example of a co-ownership cadastral plan (ground floor)

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TOWARDS 3D LAND REGISTRY IN HUNGARY

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ABSTRACT

New Act on Surveying and Mapping Activities, accepted by the Hungarian Parliament in May 2012, introduced 3D Land Registry. 3D Land Registry will work in unified environment, in the Unified Land Registry of Hungary, which was established in 1972. New legislation introduced the definition of 3D properties, the different rules for managing rights, restrictions and responsibilities in 3D space. Institute of Geodesy Cartography and Remote Sensing (FOMI) has a key role in this development. Development contains not only the legislative, but the geometric, GIS aspects as well. The paper deals with the current development issues both in legal and cadastral mapping field as well.

Key words: Cadastre, Land Administration, Land Registry, 3D Cadastre, GIS

INTRODUCTION

Hungary has a long tradition in cadastral surveying and land registration. The first cadastral survey of the country started at the mid of the XIX. Century, in the ages of the former Austro-Hungary. Surveying and registration of lands finished at the end of the Century. It means all the lands in Hungary have been surveyed and registered since the end of the XIX. Century.

At this time, the main goal of the Cadastre was the taxation of land. Cadastral surveying and land registry were separated. Registration of Condominium Units (CUs) has started in the 1930's.

Developed registration process was quasi 3D registration of CUs. Identification of CUs linked to the cadastral parcel number and the building in where the unit was. Each floor of the building had a layout plan, on which the CUs were delineated. This process remained the same until now. Registration of cadastral parcels based on a typical 2D registration method, no 3D aspects had been taken into consideration.

Operation of Land Registry and Cadastral Mapping was persistent during the socialist ages, because private ownership on land and real properties was existed.

In 1972, because of the large number of discrepancies between the Land Registry and Cadastral Map, Hungary introduced a new, Unified Land Registry, in which Land Registration and Cadastral Mapping, is the responsibility of the same organization the Land Office Network. Land Offices have to update Land Registry and Cadastral Maps together, on an integrated way. Land Offices' tasks are also Agricultural Land Valuation, Land Protection, Land Consolidation and Land Lease Registration altogether.

Institute of Geodesy Cartography and Remote Sensing (FÖMI) developed a standard (MSZ 7772:1-1996, Digital Base Map, Conceptual Model, DAT Standard) on Cadastral Map Database. DAT Standard is an object-oriented data model for cadastral map database. Based on DAT Standard new (mandatory) instructions have been developed for cadastral surveying and mapping activities in Hungary, which was introduced in 1997. DAT Standard was approved by the Hungarian Standards Institution in 1996 (IVÁN et. al. 2004).

New standard and instructions totally reformed the Hungarian Unified Land Registry. Object-oriented database view of Cadastre inspired many software and IT system developments. IT developments of Hungarian Land Administration are the responsibility of FÖMI. Until now FÖMI developed many IT systems for Land Office Network:

- TAKAROS (IT system for the management of Land Records and Legal Data, Application management, Statistics, Reporting, finished in 2000),
- FÖNYIR (IT system for Land Lease Register, finished in 2000),
- TAKARNET (Network of Hungarian Land Administration, Unified Land Registry Services for the users, finished in 2003),
- DATR (Integrated Unified Land Registry Management IT system, Management of Land Records and Cadastral Map by integrated way, finished in 2010),
- MENYÉT (IT system for Farmer's Registry, finished in 2014).

Development of an IT system has never finished. Continuous update, customization of the systems for the changing technical and legal environment is a very strict requirement. Since all the codes were developed by FÖMI en-bloc, this development task is a permanent duty of our institute.

All these IT systems are based on the DAT Standard. Reliable operation of the systems shows the success of our developments. Core data model of DATR system acts as a country profile in Land Administration Domain Model (ISO 19152:2012) Standard.

After the political changes at the beginning of the 90's the newly established local governments had not enough financial resources, therefore they sold out the flats and other properties for the citizens. This action caused a huge increase of the number of condominiums and registration of them.

Development in urban infrastructures (e.g. roads, railways etc.), privatization of infrastructure companies (e.g. utilities, water supply, sewerage, electricity etc.) increased the value of properties and the number of privately owned infrastructure elements as well. Fast development leaded to intersecting, overlapping objects, which could not be registered in a traditional 2D Land Registry. Utility networks, which owned by different companies, also rose registration problems. Hungary has 22 wine-growing regions with a lot of cellars in the hills. Under the traditional 2D Cadastre regulations registration of cellars as individual properties within a cadastral parcel cannot be executed, because it is a part of the cadastral parcel. In the case of cellars registration of them is a very important issue for wine-makers.

Samples can be counted, but these were the reasons, why Hungary changed Act on Surveying and Mapping Activities and Act on Land Registry introducing 3D Land Registry in 2012.

NEW ACT ON SURVEYING AND MAPPING ACTIVITIES

The goal of Act on Surveying and Mapping Activities is to determine the tasks of the State in Surveying and Mapping and to establish a condition system, which provides map databases in a cost-effective way for the whole economy and society.

The main issues, which are handled in this Act are the following:

- State works and State Data
    - State Databases
    - Data Services,
    - Control Networks
- State Databases
    - Database of State Boundary
    - Database of Control Points,
    - State Cadastral Map Databases,
    - State Topographic Databases,
    - State Remote Sensing Databases,
    - Databases for State Defence,
    - National Gazetteer,
    - Archive Databases.
- Surveying and Mapping Activities
    - Mounting and measuring surveying marks
    - Ownership of surveying marks,
    - Protection of Surveying Marks
- Ownership of Surveyed Data
- Institutional Issues in Surveying.

New concept on Surveying and Mapping activities changed from the old, map-based regulation to database fundament. State Cadastral Map Database is the geometric part of the Unified Land Registry Database, which is defined in the Act on Land Registry. Unified Land Registry Database contains two main parts, Cadastral Map Database and the Database of Land Records, which must be integrated.

Topographic mapping activities are shared between the public (FÖMI) and military mapping agencies. Large scale (1:10 000) topographic mapping is the responsibility of public (FÖMI), while smaller scale topographic mapping belongs to the military mapping agency.

State Remote Sensing Databases are Orthophotos, Satellite Images, LIDAR (including Terrestrial LIDAR technics), Photogrammetric products, which production is financed by the State are also regulated. There is a very strict statement in the new Act, which really helps the renewal, updating and production of State Map Databases:" A copy of any map database product, of which production is fully or partly financed by public funds, must be provided for FÖMI, without any financial and natural compensation." This means that every map database, produced in Hungary, of which production financed by public money, can be used for State level map database renewing, establishment. It is very important, if the financial resources in State Budget are generally low or not existed (like in Hungary). This statement really helps the Hungarian Mapping Agencies in their work.

New concept also includes 3D Cadastral issues, which determine that 3D parcels, related to Land Registry, should be stored in State Cadastral Map Databases. Because of the importance of 3D Cadastre solution (e.g. Condominiums in Hungarian Land Registry are registered since 1930's as quasi 3D parcels), Hungarian Land Administration Sector now is elaborating the legal restrictions of 3D Cadastre.

Act on Land Registry defines a Unified Land Registry, which means the legal and geometric (cadastral map) part of the Unified Land Registry compose one system. All geometric characteristics of Land Registry components (parcel boundary, area etc.) are derived from the State Cadastral Map Database. The Database of Land Records and State Cadastral Map Database compose one Database, Unified Land Registry Database.

This Act defines cadastral parcel, which is a continuous part of the Earth's surface, on which the ownership relationships are homogenous. There are other types of real properties beside cadastral parcels, which are the components of Land Registry (e.g. buildings, condominiums, flats, shops etc.).

Former Act defined some 3D Cadastre issues. These are the registering of condominiums, flats, shops, other areas within the condominium, cellars with access to public domain etc. Registering of these 3D situations, based on the 2D cadastral map. For example flats, shops are not the part of Cadastral Map Database, these are described by the floor layout plans, which act as Cadastral Map of Condominium Units. Change management of them is a very hard work. Cellars are described only by the line of access of them in the Cadastral Map Database.

Because of the above situation, and introducing a real 3D Cadastre in legislation, the renewed Act on Land Registry defines a new type of property, which open the doors to 3D Cadastre.

This new type of property is defined by the follows:

"Under-ground and above-ground passes, objects, structures, which has homogenous ownership relationships should be taken into account as property, which must be registered in Land Registry."

With the help of this definition utilities, over-crossings and other objects (e.g. cellars) should be registered as property and 3D legal relationships should be modeled in Hungarian Unified Land Registry.

Versus with some 3D Cadastre solution, the Hungarian concept registers 3D object in space. Connecting legal space of 3D object should be derived from the geometry of the objects itself and other regulations (e.g. spatial planning regulations).

Legal space required for 3D Cadastre object is defined in different Laws, Regulations related to Land Use and Land Development in Hungary. This means if 3D objects and their legal space should be registered in Land Registry, the required legal space must be modeled based on regulations.

The Act authorizes FÖMI to elaborate the required legal and technical regulations for the implementation of 3D Cadastre in Hungarian Unified Land Registry. Therefore 3D elements of the Act will not come into force immediately, only after these regulations and technical conditions are ready.

LEGAL ISSUES

Civil Code of Hungary defines the extension of ownership on real-property as follows: ”Ownership right on a real-property extends to the air-space above and to the subsurface below it until utilization is possible”. It is a typical ”from-heaven-to-hell” situation as in many countries all over the world.

Fortunately the word ”utilization” can limit the infinite extension of property rights. The main legal problem in the introduction of 3D Land Registry is the legal handling of 3D situations, for example on Figure 1:

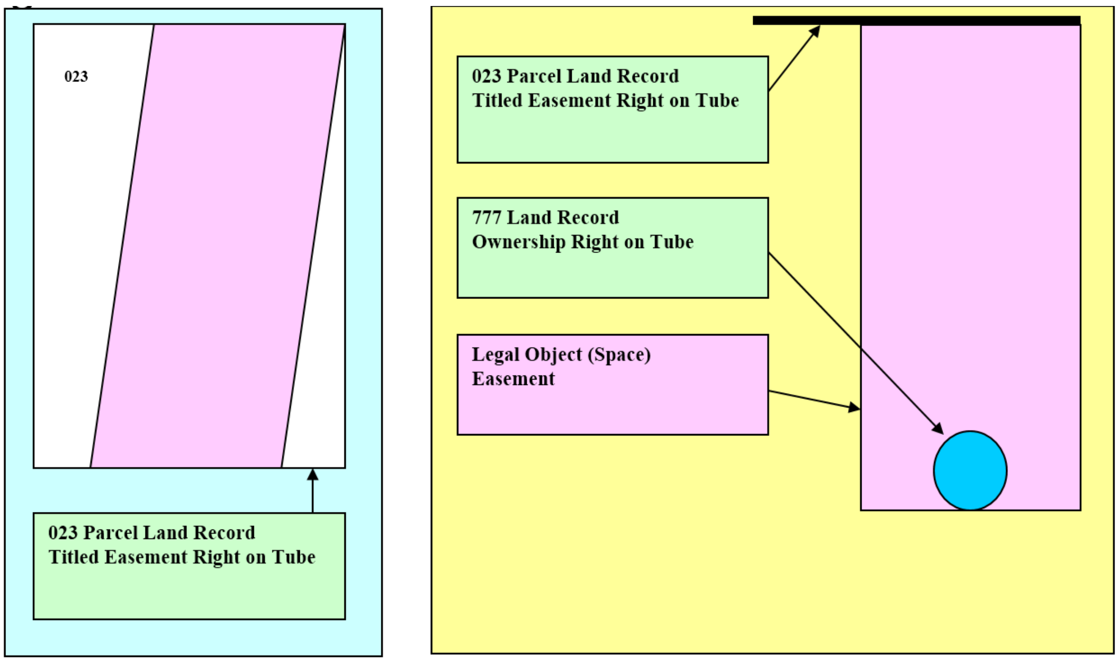

Figure 1: 2D and 3D Land Registry situation

On Figure 1 a typical situation is shown. There is a cadastral parcel (number: 023), and under the parcel there is a tube, of which owner is different from the cadastral parcel’s owner. Based on the regulations on tubes, a tube must have safety zone, which is defined by the certain distance from the axis of the tube.

In 2D situation the tube is surveyed, and the safety zone is defined. If the safety zone intersects a privately owned cadastral parcel (023) the safety zone must be inserted into the cadastral map database and an easement right must be registered on this cadastral parcel in Land Registry.

In 3D situation the tube, oneself is a property. It has a land record in Land Registry. But the tube generates a legal space (safety zone) around it as well. A new, legal object must be introduced, which defines the safety right of the tube. This legal space intersects the legal space of the cadastral parcel (023), the intersection of the two legal spaces generates an easement right on the cadastral parcel.

In the legal solution of 3D Land Registry such intersections, touching, overlapping of legal spaces and the arising rights must be modeled techically and legally as well.

Legal and technical issue is the identification of 3D properties. On Figure 2 a cadastral map is shown and there is a 3D object, which overlaps cadastral parcels:

Figure 2: 3D object overlaps cadastral parcels

Generally there are two solutions for the unique identification of such object:

- intersecting the object with the cadastral parcels, and split it into as many pieces as many cadastral parcels overlapped,
- no intersection, keep the 3D object as a whole, but some unique identifier should be assigned to it.

In Hungary the second solution is supported, because splitting dissolves the object and its registration and lose main meaning of it. The object, which overlaps parcels (under or below the surface of the earth) must connect to a physical object within a cadastral parcel (e.g. pillars of a bridge, transformer house of a electricity cable, gas distributor station of gas pipeline etc.). For the unique identification of 3D object these "starting" cadastral parcel identifier should be used with some other identifiers, which uniquely identify the 3D object. This identification can connect 3D object identifiers to the traditional 2D identification. The whole concept of such "octopus" identification has not been finish yet.

GEOMETRIC MODEL

There are different recommendation, solutions for modeling legal spaces in 3D Cadastre. One of the most known was published in LADM, which was using boundary face concept for 3D representation of legal spaces. It has a great advantage, because mixed representation of 2D and 3D legal spaces is also available using boundary face string and boundary face solutions (ISO 2012).

The author recommended the usage of homogenous coordinates for managing unbounded legal spaces, or the tesselation of legal spaces by using tetrahedrons (IVÁN, 2012). This solution could be really flexible, but the management of homogenous coordinates could cause computational problems. Tesselation of space requires that all parts of the space should be tessellated, which requires a lot of computation and storage, and mixed 2D and 3D situations cannot be handled in this way. In the future, taking into account the development of ICT technology, this solution could be introduced.

The Hungarian Cadastral Map Standard and the IT system of the Unified Land Registry is using the concept described in DAT Standard. DAT Standard is using 3D points as default for the representation of geometry of the Cadastral Database. Until now only the 2D capacity of the model was used, generally the "Z" coordinate of a point was set to zero (except in the case of vertical ground control points, which require the "Z" coordinate). The sketch of DAT Standard geometry can be found on Figure 3.

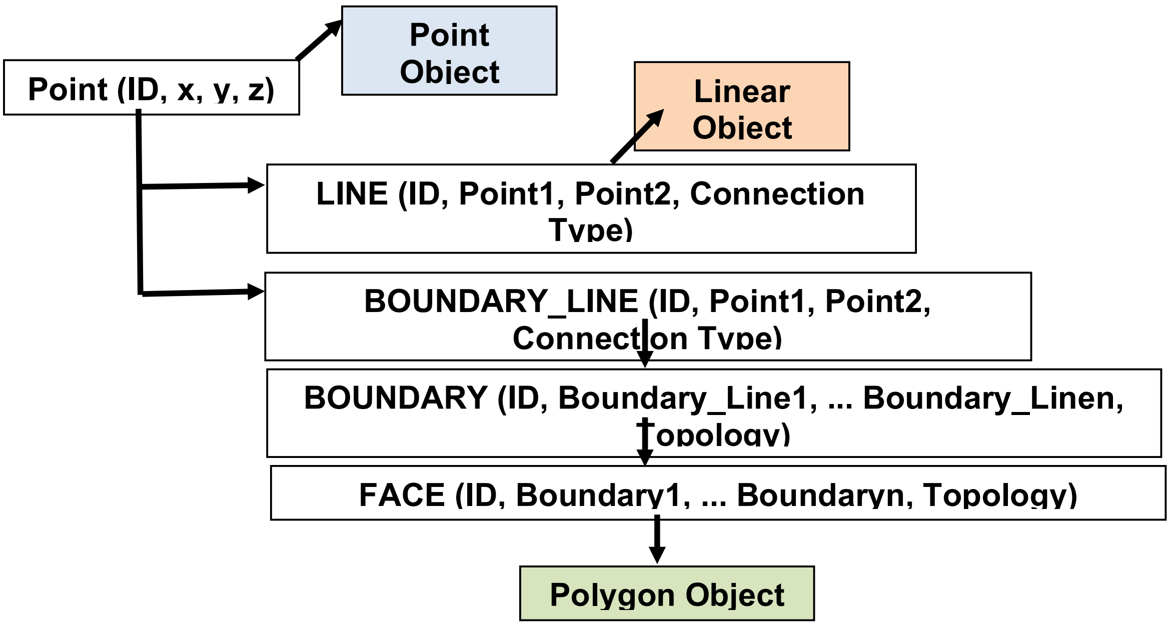

Figure 3: Geometric Concept of DAT Standard

The base is the class Point, which describe the positions (3D as default). If an object is a point type object, it is directly linked to Point class. Line is a class, which stores Points describing a line. Connection type is line as default, but curved connection is also available. If an object is a linear object, it linked to class Line. Boundary_Line class is similar to Line, except it must be a part of a boundary. Boundary is a set of connected Boundary_Lines and it must be closed. Face is a composition of boundaries. Face must have only one outer and zero or more inner boundaries. Polygon type objects are directly linked to Face, describing their geometry. This concept is very similar to any GIS systems concept is it is a 2D situation.

DAT Standard based solution for modeling 3D legal spaces is based on the condition that the legal spaces are not unbounded or can be closed in the finite. Boundaries of legal spaces are represented by planes (no curved surfaces are allowed, Figure 4).

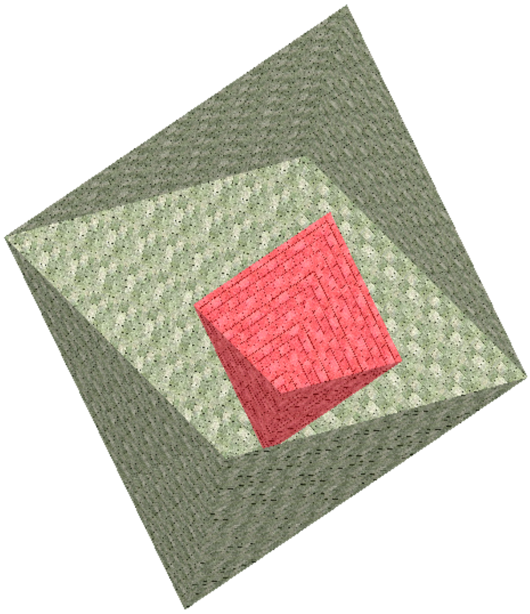

Figure 4: Legal spaces delineated by planes

On Figure 4 two legal spaces are shown delineated by planes. The outer (green) legal space contains an inner legal space (red), which is not a part of the green one (hole in the space).

If the original geometric construction of DAT Standard is used, Face class should describe the planes, which delineate the legal space. In Face class holes within a face are also allowed. For the usage of Face in 3D a co-planarity constrain is required as defined in the following formula:

$$\text{Det}\begin{bmatrix} X_1 & Y_1 & Z_1 & 1 \\ X_2 & Y_2 & Z_2 & 1 \\ X_3 & Y_3 & Z_3 & 1 \\ X_i & Y_i & Z_i & 1 \end{bmatrix} = 0$$

where:

- X_1,Y_1,Z_1 – *are the coordinates of point 1 on the face, which cannot be collinear with point 2 and 3,*
- X_2,Y_2,Z_2 – *are the coordinates of point 2 on the face, which cannot be collinear with point 1 and 3,*
- X_3,Y_3,Z_3 – *are the coordinates of point 3 on the face, which cannot be collinear with point 1 and 2,*
- X_i,Y_i,Z_i – *are the coordinates of point i on the face, i = 4..n, n is the number of vertices of the face.*

Constrain: Faces should have only one outer boundary, no multiple faces are allowed.

DAT Standard geometry has been expanded with two geometric primitive: shell and legal space. Shell is the polyhedron, which bounds a legal space. Legal space is a set of shells (or one shell), which describes the 3D land registry entity. The following definitions and constrains were defined (IVÁN, 2014):

- Outer shell of legal space is the shell, which bounds the legal space. There is no same legal space (regarding to Land Registry) outside this shell,
- An edge of a shell is the intersection of only two, and only two Faces[1],
- Legal space has only one outer shell,
- Outer shell cannot intersect or touch oneself,
- Inner shell of legal space is a shell, which is entirely within the outer shell of the legal space, and bounds a legal space, which is different from the legal space is bounded by outer shell (regarding to Land Registry (see Figure 4, red space),
- Inner shell cannot intersect or touch outer shell,
- Inner shell cannot intersect or touch oneself.

An example of the usage of these rules is shown on Figure 5:

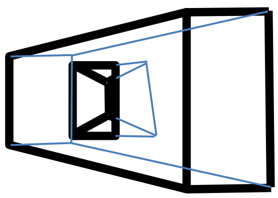

Figure 5: Legal space description by shells

By the usage of above expansion of DAT Standard geometry model 3D legal situations can be modeled in the existing Hungarian Land Administration IT environment. It is a flexible solution, because 3D Land Registry is required anywhere. At that places the original 2D model can be used and mixed use of 2D and 3D geometry also available, because 3D solution is based on the 2D primitives.

CONCLUSION

Hungarian Unified Land Registry has enough resources for the introduction of 3D Land Registry in Hungary. Introduction must be very careful, an agenda should be planned, because not only human and IT resources are needed, but a huge financial and surveying capacity are required as well. FÖMI is working on the implementation of the system both on legal and technical level as well.

[1] This constrain is nearly the similar to Euler's Polyhedron Formula V-E+F=2, where V is the number of vertices, E of the edges and F os the Faces, but not the same, because holes are allowed ont he Faces

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THE UNDERGROUND SPACE USE RIGHT REGISTRATION WITH THE APPROACH OF 3 DIMENSIONAL CADASTRE CONCEPST (CASE STUDY COMMERCIAL MALL BELOW THE PUBLIC TRANSPORT TERMINAL BLOK M, JAKARTA)

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ABSTRACT

The limitation of land and technological advances in the development of urban areas has changed the orientation of development to the vertical direction in the form of utilization of space above or below the land. Currently, the form of underground space utilization is not well accommodated by the right institutions in Agrarian Law Number 5 Year 1960 and National Land Registration Law Number 16 year 1985 which cover the utilization of three-dimensional space that is not located on the land surface. Therefore, it is necessary to have a special regulation regarding provision of rights and cadastre registration, applying three-dimensional (3D). The object to be studied in this paper is the commercial mall building below the Public Transport Terminal at Blok M area which located in Southern Jakarta. The data collection includes physical and juridical data. Physical data processing is done by digitizing the image construction of building to obtain the 3D shape of building in a digital format while the juridical data processing with the 3R approach *(right, restriction, responsibility)* and the 3D cadastre approach produce proposition of new right form and registration right form. The 3D cadastre concept which used is the *hybrid cadastre* method with an alternative of *registration of 3D physical object.* This paper has resulted the proposition of new right form namely the Underground Space Use Right (HGRBT) as well as form for right registration with the support of spatial object form in 3D. Implementation of HGRBT registration on the object of research was expected to provide guarantee of legal certainty to the parties concerned.

Key words: 3D cadastre, underground space

ABSTRACT (in Indonesian Language)

T Keterbatasan tanah dan kemajuan teknologi pembangunan di wilayah perkotaan telah mengubah orientasi pembangunan ke arah vertikal dalam bentuk pemanfaatan ruang di atas atau di bawah tanah. Saat ini, bentuk pemanfaatan ruang di bawah tanah belum diakomodasi oleh lembaga hak baik dalam UU No. 5 Tahun 1960 maupun UU. No. 16 Tahun 1985 dimana bentuk pemanfaatan mencakup ruang berdimensi tiga yang tidak terletak pada permukaan tanah. Oleh karena itu, diperlukan pengaturan khusus menyangkut pemberian hak dan pendaftarannya dengan menerapkan konsep kadaster tiga dimensi (3D). Obyek pada penelitian ini adalah bangunan mal di bawah terminal Blok M. Pengumpulan data meliputi data fisik dan data yuridis. Pengolahan data fisik dilakukan dengan digitasi gambar konstruksi bangunan untuk memperoleh bentuk 3D bangunan dalam format digital sedangkan pengolahan data yuridis dengan pendekatan 3R (*right, restriction, responsibility*) dan pendekatan kadaster 3D menghasilkan usulan bentuk hak baru dan bentuk pendaftaran haknya. Konsep kadaster 3D yang digunakan adalah metode *hybrid cadastre* dengan alternatif *registration of 3D physical object*. Penelitian ini telah menghasilkan usulan bentuk hak baru yaitu Hak Guna Ruang Bawah Tanah (HGRBT) serta bentuk pendaftarannya dengan dukungan bentuk spasial obyek secara 3D. Implementasi pendaftaran HGRBT pada obyek penelitian diharapkan dapat memberikan jaminan kepastian hukum kepada pihak-pihak yang berkepentingan.

Kata kunci : kadaster 3D, ruang bawah tanah

INTRODUCTION

Background

Cadastre System (land registry) that prevail in Indonesia today still use land parcels of 2D (two dimensional) as the basic entity of right registration. The advances of developing technology in an effort to overcome land limitation especially in urban area has changed the orientation of development to vertical direction in the form of utilization of space above or below the land. This means the cadastre object has been developed into three-dimensional space that is not located on the land surface so the 3D cadastre approach is necessary in cadastre affair.

Any usage and mastery of land by anyone and for whatever purposes, should be based on a right under national law in accordance with the allocation of land and its usage (Boedi Harsono, 1999). National land law is currently more regulate rights on the land surface (Maharani, 2008). This means the law of the land now only related to the rights existing above the land and has not accomodated the mastery of underground space. Usage of the underground space is not included in the scope of the authority which is based on land rights that is in the national land law today (Hutagalung, 2008). Regulation in land such as the Law Number 16 Year 1985 is more regulates granting the right settings for the utilization of space for apartment building that in fact located on the land surface.

Based on the above matter, the usage and mastery form of space in the underground building has not been accommodated by rights have been stipulated in Law Number 5 Year 1960 and Law Number 16 Year 1985. Therefore, we need a form of new right that can be called Underground Space Use Right (HGRBT) where the implementation needs the 3D cadastre approach.

Problem Formulation

The problem formulation in this research is how the implementation of Underground Space Use Right registration with the approach of 3D cadastre concept?

Hypothesis

This research is conducted based on the hypothesis that Underground Space Use Right registration can be realized with a 3D cadastre concept approach.

Objective

The purpose of this research is to study the implementation of Underground Space Use Right with a 3D cadastre concept approach.

Benefit Research

The result of this research may provide benefit in developing a knowledge in land registration field, particularly regarding the object of underground space. In addition, the result of this study is expected to contribute in improving the land registration policies, particularly those related to the usage and mastery of space below the land.

Expected Results

This research is expected to produce a study regarding Underground Space Use Right registration with 3D cadastre concept approach.

Research Scope

- 3D cadastre in this study is established with the aim to support the implementation of HGRBT registration on the forms of usage and mastery of space at the Blok M mall building.
- Location of case study in this research is Blok M bus terminal located at Jalan Sultan Hasanuddin, Melawai Village, Kebayoran Baru District, South Jakarta. Usage and mastery of the underground building has been real in this location in the form of Blok M mall shopping center.
- The usage of underground space in this research is a form of usage of which on the land surface used as public facilities (Blok M terminal).
- The usage of underground space in this research is not part of land use on it. It means the usage of underground space to be separated with the usage on the land surface.
- The physical data (construction and plan drawings) and juridical data (usage and mastery of building data) acquired from Blok M terminal manager in 2010. Besides of the data above, this research also use the regulation which related to underground space utilization and regulation in the land sector to study the right formation and right registration as a juridical basis for the usage and mastery of underground space in Blok M mall building.
- Software used to create 3D images of Blok M mall building in this study is the AutoCAD software.

METHODOLOGY

Preparation

Literature review or literature studies, determining location in accordance with the theme of research, identifying the 3D cadastre object, and prepare a research tools.

Data Collection

Data collecting consist of physical and juridical data. Physical data are the construction and plan drawing of Blok M mall building. Construction drawing is drawn again using a computer with AutoCad software to obtain construction drawing in digital format. Juridical Data are usage and mastery data of Blok M mall building, the regulations related to underground space utilization and regulations in land sector

Data Processing

Data processing activities include the selection of 3D cadastre method, 3D building shape design, right form, and right registration form. Construction drawing was digitized to obtain the 2D shape of building which was then undertaken "*extrude*" to obtain 3D building shape in digital format.

From the juridical data in the form of regulation of land rights was established right design with the 3R approach (*right*, *restriction* and *responsibility).* From the juridical data in the form of regulation regarding land rights registration established right registration design with 3D cadastre approach

Data Analysis

Analysis of 3D building shape of Blok M mall; right form; right registration form is done by comparing the rules in the proprietary right of Housing Units (HMASRS). This analysis considerated regarding location, shape, structure and usage, where the mall building was assumed as non-residential flat.

Conclusion

Conclusions from the results of analysis and provide suggestions

Flow Diagram

RESULTS AND DISCUSSION

Selection of 3D Cadastre Method

- To determine the 3D cadastre method that will be applied at Blok M mall building, required the consideration of the ease in adjusting to the prevailing system of land law in Indonesia. 3D cadastre method that can be applied to Blok M mall building is a *hybrid cadastre* with an alternative *registration of 3D physical object.*

- The method of *hybrid cadastre* with alternative *registration of 3D physical object* is selected with the consideration that the current land registration law in Indonesia has not made the 3D space as the basic entity in right registration and still made 2D parcel of land as a basic entity in land registry. Therefore, the formation of 3D cadastre can begin by integrating the 3D property situation on the basis of 2D entity.
- This method is performed by registering the physical object in the form of mall building including spatial information in it. The aim is to describe the 3D situation of Blok M mall building so that information can be used to determine the position of right status and three dimensions situation in the 2D entity.

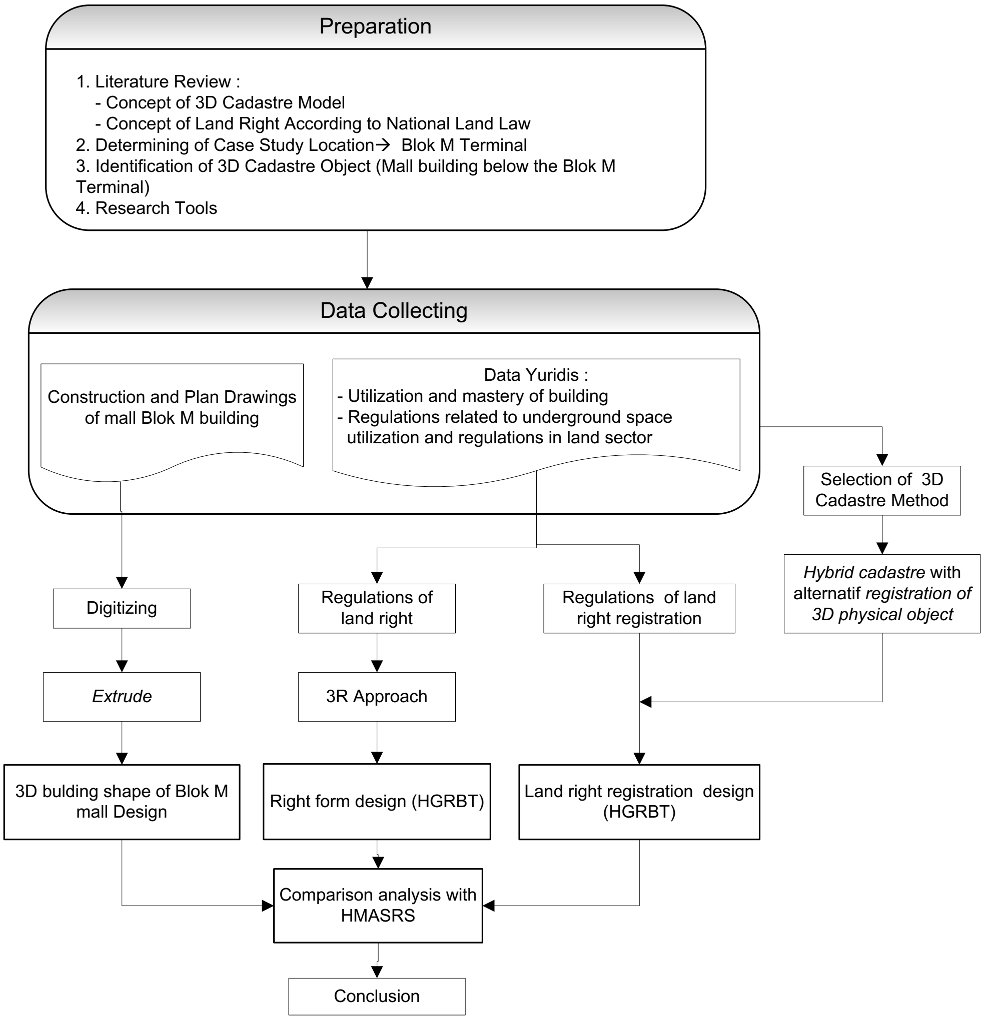

Figure 1 Research Phase

3D Building Shape

3D shape of Blok M mall building is obtained by processing the physical data in the form of building construction drawings (Figure 2 and 3). The construction drawings were digitized by assisting AutoCad software to obtain 2D building shape (Figure 4 and 5). While digitizing, geometry images of building that used as stores and non stores are directly distinguishable by giving a different color. Type of usage of building units in the Blok M mall can be seen from the building plans. The building units that had a certain number were identified as a store (see Figure 6 and 7).

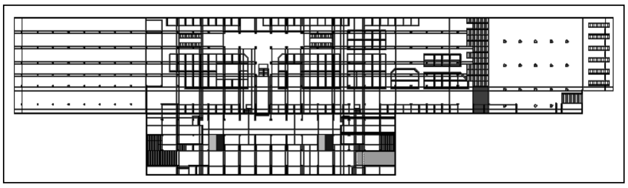

Figure 2. Construction drawing of Blok M mall building at B1 floor

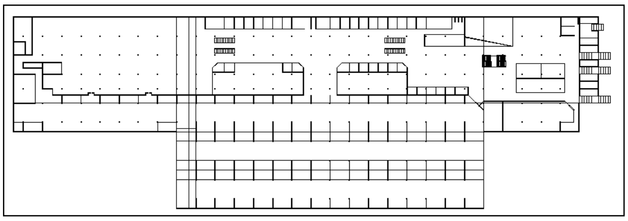

Figure 3. Construction drawing of Blok M mall building at B2 floor

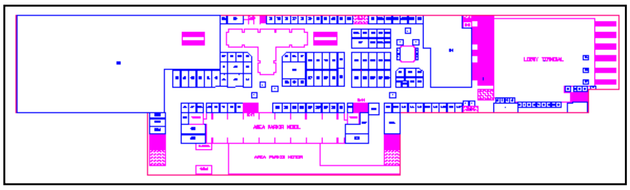

Figure 4. 2D building shape of Blok M mall at B1 floor

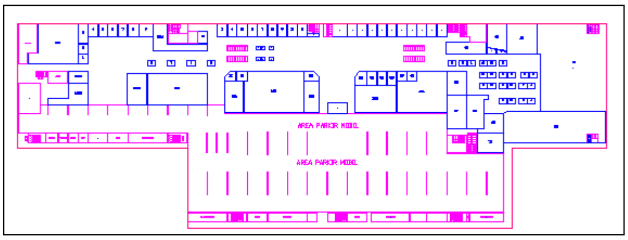

Figure 5. 2D building shape of Blok M mall at B2 floor

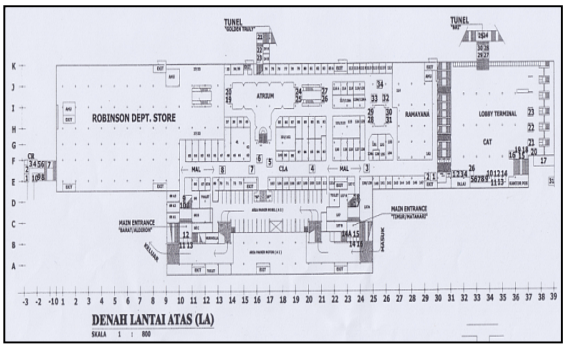

Figure 6 . Blok M mall plan drawing at B1 floor

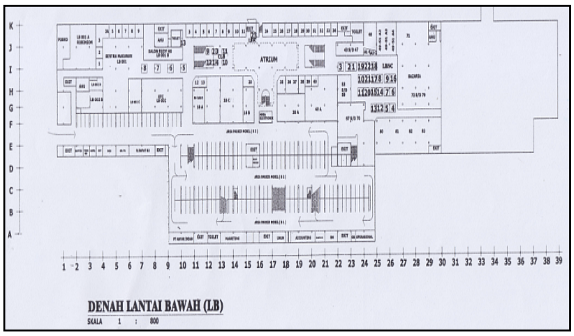

Figure 7. Blok M mall plan drawing at B2 floor

The 3D building shape which formed is *solid* 3D shape which is formed by giving the height *(extrude)* to the 2D building images (Figure 4 and 5). The 2D objects were extruded to be *solid* 3D objects in the direction of z axis by helping the "*extrude"* command in AutoCAD software.

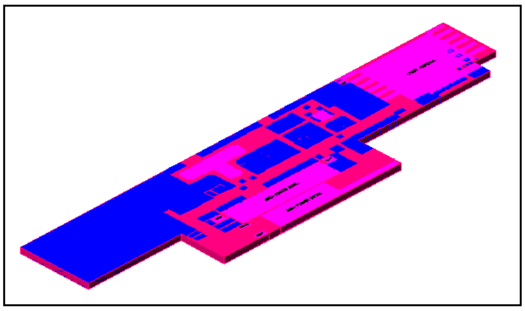

Figure 8. S*olid* 3D shape of Blok M mall building at B1 floor

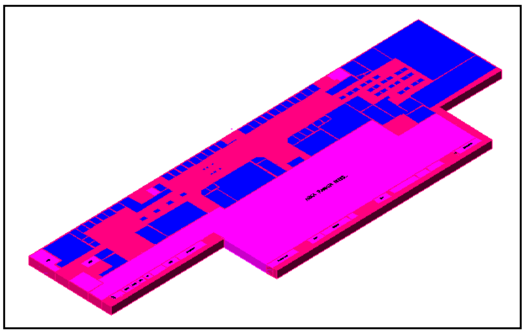

Figure 9. S*olid* 3D shape of Blok M mall building at B2 floor

Figure 8 and 9 visualize the *solid* 3D shape of Blok M mall buildings at B1 and B2 floor. In this form, limitation of space usage can be distinguished and clearly visible. Building Units used as stores were bordered by blue colors and the property used as non-store were bordered by magenta colors (purplish red). The *solid* 3D shape of mall buildings at B1 and B2 floor can be unified into a single mall building in an integrated form (Figure 10).

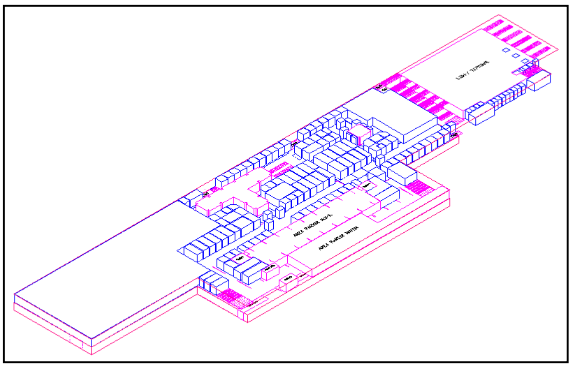

Figure 10. Union of 3D building shape at B1 and B2 floor

Right Form

Indonesia's national land law was stipulated in Law Number 5 Year 1960 about on Basic Agrarian Laws (UUPA). Under Article 4 of UUPA, land rights give an authority to use the land, land bodies and water as well as existing space above it, just needed to interests that are directly related to the usage of the land. Outside of those strata, the usage and mastery of the underground space are not included in the authority of the land rights and require specific regulation in a form of new right.

The establishment of new right can be done by adopting and modifying the form of rights as stipulated in the regulations concerning land rights. Form of right that is formed can be called with Underground Space Use Right (HGRBT) because of its mastery coverage includes three-dimensional space which is located below the land. Designing of HGRBT form was done with the 3R approach *(right*, *restriction,* and the *responsibility)*.

Form of authority *(right)* in HGRBT include:

a. HGRBT gives authority to use three-dimensional space in the body of the land (underground) within a certain time period.
b. HGRBT gives authority to use part of the land surface above it as a place to build facilities liaison (entrance and exit) to the underground building. Usage of this land surface must be based on a land right.

Forms of right restrictions includes:

a. Time period of right. The usage of underground space is realized in the form of construction of buildings below the land so that to determine time period of the right must consider the age and strength aspects of building construction.
   Under Article 35 of UUPA, land right associated with the construction of the building is Hak Guna Bangunan (HGB) that were given a period of 30 years. Indonesian Institute of Architects, Honorary Chairman, Budi Sukada, had issued a statement that the construction of buildings in Jakarta have been designed with the age of 50 years and the buildings have earthquake resistance until 10 SR (beritajakarta.com, 2009). In addition, the general explanation of Article 5 subsection (3) Government Regulation Number 36 Year 2005, explained that the permanent building means a building whose function is planned to have the services above age of 20 years.

Based on explanation above, therefore HGRBT granting can be given with consideration for time period of 30 years and renewable for 20 years.

b. Subject of HGRBT is legal entity located in Indonesia.
c. Depth of land aspect on HGRBT means HGRBT still may be granted until a certain depth. Depth aspect related to the soil bearing and the environment capacity of the place that will be used for underground construction.

Form of responsibilities include:

a. Prevent damage to the body of the land and the environment which may cause disturbance of land usage on it.
b. The holder of HGRBT must obtain written permission from the owner / holder of land rights that exist on it to use space below the land and to use the land surface to build facilities liaison (entrance / exit) to the underground building.
c. In the process of granting right, HGRBT holders are required to pay revenue to the state.

Right Resgistration Form

As mentioned previously, the method implemented in 3D cadastre was *hybrid cadastre* with an alternative of *registration of the 3D physical object.* This method applied at Blok M mall building where the 3D situation of mall building added on basic entity of 2D registration. At the top *(emplasement* of Blok M terminal) where at the bottom there is a mall building registered with the land right, namely right of management (HPL) because this parcel mastered by the Government of DKI Jakarta whereas the mall building is given HGRBT.

Developer who develops Blok M mall is PT. Langgeng Ayom Lestari incorporated as an Indonesian legal entity. To be able to use the land surface associated with the mall building then the developer must obtain licenses and make a written agreement with the Government of DKI Jakarta. On the basis of this agreement, the developer can apply for land right as the basis for the usage of the land surface. As for the land right granted is Building Use Right (Hak Guna Bangunan).

In the *hybrid cadastre* method with alternative of *registration of 3D physical object,* the physical object of Blok M mall building is registered and then integrated into the land registry map (2D). This is intended to make building have the same coordinate system of land registration map, which is in the coordinate system of TM-3 ^{0} (x and y axis). For the height (z axis) refers to the local coordinates by making the surface of the terminal that has the same relative height and flat with the land surface as the zero point (z = 0).

Design of HGRBT registration form was done by adopting land rights registration form as set out in UUPA and Government Regulation Number 24 year 1997 about Land Registration. The aim is HGRBT already formed can be registered in the cadastre activities. HGRBT registration is conducted through the process of granting right with the decree of granting right decided by the competent authority.

HGRBT registration made after the prospective right holder qualify technically and administratively. Technical requirements related to technical requirements of the building while the administrative requirements related to allowance must be met by the prospective

HGRBT holder that is local government allowance and written consent (agreement) with the owner / holder of land rights on it.

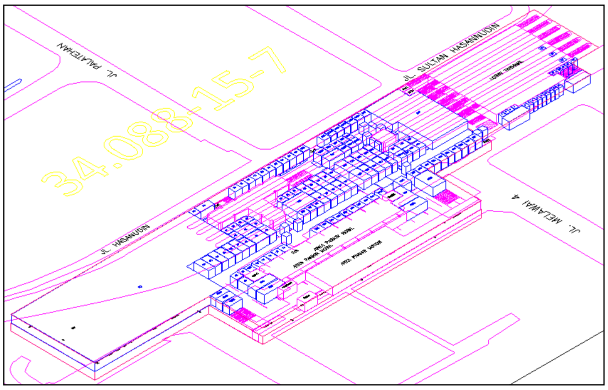

Figure 11. Visualization of Blok M mall building in the land registration map

Product of this granting HGRBT process is document of certificate and Space Book (identical with the Land Book) of HGRBT. Space Book is a document that contains the physical and juridical data of HGRBT object that has been registered. Whereas HGRBT certificate is valid proof for the usage and mastery of space in the underground building. The form of Space Books and certificate of HGRBT can modify the form and format of Land Book and Certificate of Ownership of Land (HAT) as was stipulated in the current land registration laws (Appendix 1 to 3).

As land rights, physical data of HGRBT object contained in a document of measurement certificate which became part of the HGRBT Space Book and Certificate. The form and format of measurement certificate can modify the form of measurement certificate on land rights (Appendix 4 to Appendix 6).

Analysis of 3D Building Shape and Right Form

Based on Government Regulation Number 36 Year 2005, Blok M mall building as an underground building can be assumed as non-residential flat. Based on this, the analysis carried out by comparing the 3D building shape, right form, and right registration form towards setting proprietary right of Housing Units (HMASRS).

Basically, for the usage and mastery of the underground building can be given as one HGRBT. This means that HGRBT attached to the mall building as a whole and owned by a right subject namely PT. Langgeng Ayom Lestari as the developer who built Blok M mall.

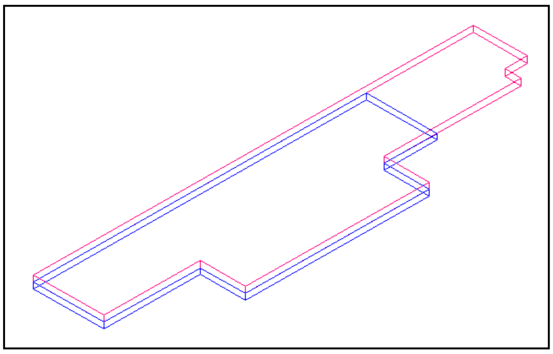

Figure 12. Space boundary for HGRBT at Blok M mall

In fact, Blok M mall building consists of several building units (underground space units) and most of those can be used individually as a store. The existence of underground space units that is used by an individual is certainly going to involve many stakeholders as users. Based on this condition, each subject of underground space unit requires a much legally stronger position in using and mastering the underground space unit.

By comparing the rules in the HMASRS, HGRBT inherent in Blok M mall buildings can be separated into several underground space units that can be given right separately and can be called with the proprietary right of Underground Space Unit (HMASRBT). As in HMASRS, before HGRBT separated into multiple ownership of HMASRBT, then developer must make a Deed of Separation that was approved by the local government. In this mall building, there are building units which are used as a store and can be owned with separately right and there are also part of the building can be used together such as structural columns, walls, toilets, mosque, and parking lots. The used parts for the common good may be called as jointly parts.

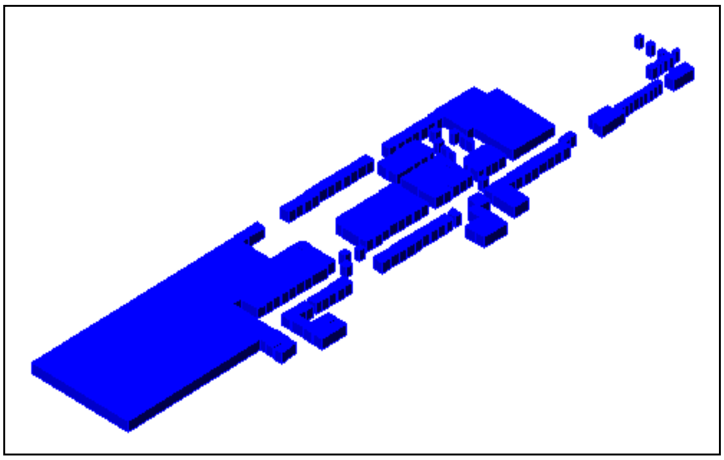

Figure 13. Underground space unit as a store at B1 floor

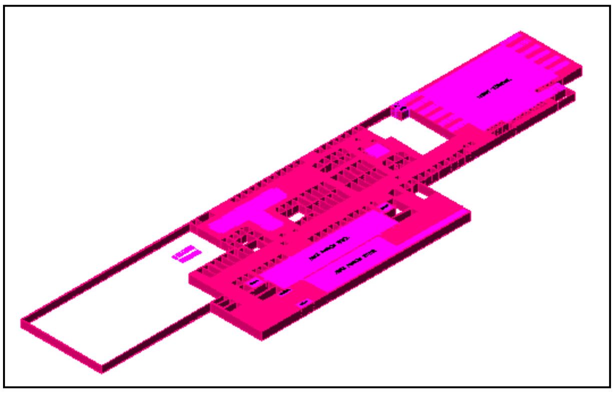

Figure 14. Jointly parts at the B1 floor

Blok M mall building is equipped with means of liaison that connects the underground building with the land surface above it. Liaison facility was built in a certain limitation of the usage of the land surface.

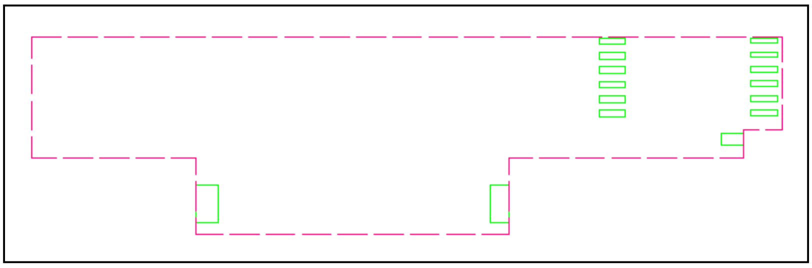

Figure 15. Parcels of land surface that are used as a facilities of liaison to the Blok M mall

Figure 15 shows that the parcels of land surface that is used as a entrance and exit Blok M mall are the parcels bounded by green color whereas the area bounded by the dashed red line is the boundary of underground space area used for construction of Blok M mall building.
Basically, underground space unit is part of an underground building that could be used as residential or non residential. Based on Article 30 Government Regulation Number 36 Year 2005, suggests that the construction of underground building that crosses infrastructure or public utilities not addressed to occupancy function/residence place. Thus the underground space units of Blok M mall can only be used as a place of non-residential (business place).

Analysis of Right Registration Form

In the case of Blok M mall, each underground space unit (store) is given HMASRBT. Granting HMASRBT can be done after granting HGRBT of the whole of mall building. By comparing the rules in the HMASRS, before HGRBT at Blok M mall building is separated into multiple ownership of HMASRBT, therefore the HGRBT holder (developer) have to make a Deed of Building Separation which was then approved by the local government.

Deed of Separation which have been made and approved by the Local Government then registered to the land office to make the HGRBT separation into multiple ownership of the underground space units (HMASRBT). Based on this, then issued certificate and Space Book of HMASRBT. In this case, the overall certificate issued on behalf of developer. Form and format of Space Book and certificate of HMASRBT can modify the form and format of Land Book and Certificate of HMASRS (Appendix 7 to 10).

In the registration process, in the Space Book and certificate of HMASRBT need to attached copy of HGRBT measurement certificate (in accordance with Appendix 4 to 6) which are compiled into one section in the Space Book and certificate of HMASRBT. At the Space Book and certificate of HMASRBT also attached copies of space and building plan drawings from developer.

The form and format of space and building plan drawings for the issuance of certificate and Space Book of HMASRBT can adopt the form and format of plan drawings at the Head of BPN Regulation Number 4 Year 1989. The form and format of these plan drawings then modified for HMASRBT registration purpose (appendix 11 to Appendix 14).

Over time it is very possible there is a change of ownership of HMASRBT and HGRBT data. Therefore, we need data maintenance activitiy of right registration to record the changes. Changes may occur due to transfer of legal right activities such as buying and selling, grants, inheritance or right encumbrance to ensure debt repayment. In the transfer of legal right process or right encumbrance process required involvement of Maker Official Land Deed (PPAT) for the process of making land deed.

When the right transfer or right encumbrance occurred then it should be noted to the Space Book and certificate. Recording is based on the deed made by PPAT as the basis for changes in registration data. With data maintenance activity of right registration, therefore any data changes of HMASRBT or HGRBT should be registered, so it's status remains *up to date* and to guarantee legal certainty to the parties concerned.

CONCLUSION

Conclusion

1. Mastering of the form of usage of space in the underground building can be accommodated in form of Underground Space Use Right (HGRBT) where the legalization process of right registration can be implemented by using *the hybrid cadastre registration of 3D physical object* method.
2. HGRBT is a right that is given as a basis for the usage and mastery of space for underground building. In the case of Blok M mall, HGRBT holder can separate the space into multiple ownership of underground space unit in the form of proprietary right of Underground Space Unit (HMASRBT).
3. HGRBT still associated with the usage of land surface and land rights above it. In this case, it's required written consent (agreement) with the owner or land rights holder on it that should be included and mentioned in the decree granting right.
4. Space Book and certificate of HGRBT can provide assurance of certainty the position and clearly boundary of space usage to the HGRBT holder.

Suggestions

1. Granting HGRBT and HMASRBT including right registration activity for legalization of mastery of space in underground building need to be regulated by law in order to guarantee legal certainty to the owners or interested parties.
2. For the registration purpose, it's required further technical study related to delimitation of underground space parcel and its mapping on the registration map. In this case also needed further study on the standardization of 3D object representations for right registration.
3. In order to provide complete information to the parties concerned about the object (physical data) and subject (legal information) of HGRBT or HMASRBT, thus the land information system development is needed regarding the existence of 3D cadastre objects.
4. Such as land rights, HGRBT or HMASRBT can be lost if the underground building was damaged or destroyed. Therefore, further study is needed about the form of building (property) insurance in order to protect the interests of right holders from losses due to natural disasters or disasters caused by human negligence that caused destruction of building.

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DETERMINING BEST LOCATION OF EMERGENCY STATIONS IN THE URBAN AREA

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ABSTRACT

Emergency medical stations and fire stations play a key role in emergency management. An early primary attack will save more lives and properties in emergency cases. Response time is a critical component which includes alarm answering time, alarm processing time, turnout time and travel time in an emergency. Travel time is one of the most important elements of the response time and it is affected by various factors; such as traffic volume, road networks, the time of day, driver habits, and the location of the incident. The strategic locations of emergency medical stations and fire stations are of paramount importance in achieving a minimal travel time which is part of an effective and reliable emergency response system. In Turkey land readjustment projects are done in order to create a regular urban area. These projects depend on a land development plan. Land development plans includes residential area, commercial area, industrial area and technical infrastructures like road, park, car park, sport area, school and other public service areas. Emergency medical stations and fire stations are important public services for the residents. Determining best location of this kind of public services affects the performance of these services. In this study, the response time and in particular the travel time criteria were determined according to the previous studies in the literature, and then existing sites of emergency medical stations and fire stations in Samsun city were evaluated according to the location of emergency calls and the eight minute response time coverage area. In addition, necessity of new stations and locations of them were determined using the Geographic Information System.

Keywords: Emergency, GIS, Land Management

ÖZET

Acil durum yönetiminde ambulans istasyonları ve itfaiye istasyonları kilit rol oynarlar. Acil durumlarda hızlı müdahale can ve mal kayıplarını önler. Bu konuda cevap süresi önemli bir kriterdir. Acil arama ve cevaplama süresi, hazırlık ve çıkış süresi, ulaşım süresi ve müdahaleye başlama süreleri cevap süresini oluşturur. Burada en etkili faktör ulaşım süresidir ve yol durunu trafik vb. Pek çok koşuldan etkilenir.Acil müdahale istasyonlarının konumu da erken müdahale için çok önemlidir. Bunların konumlarının planlanması imar planları yapılırken iyi planlanmalıdır. Bu istasyonların konumları erken müdahaledeki başarıyı doğrudan etkiler. Bu çalışmada acil müdahale istasyonlarının konumlarının en ideal şekilde belirlenmesi için cevap süresi baz alınarak mevcut istasyonların konumları CBS yazılımı desteğiyle alan kapsama analizi ile irdelenmiş ve bu istasyonların konumlarına dair yeni

öneriler getirilmiş ve ihyiyaç gönünen bölgeler için önerilerde bulunulmuştur. Samsun iline ait veriler örnek uygulama olarak kullanılmıştır.

INTRODUCTION

Accidents and emergency medical cases are a part of the human life. Studies have shown that 10% of deaths following an accident or injury take place in the first 3–5 mins, and 54%–60% within the first 30 mins.(Demirhan, 2003) Thus, emergency services must send a vehicle to the scene of a medical emergency as fast as possible. The American College of Cardiology/American Heart Association guidelines specify that an electrocardiogram should be obtained and interpreted within 10 mins of arrival to the emergency department in patients with symptoms suspicious of acute coronary syndrome.(Zègre-Hemsey etal, 2011)

The locations of fire stations have paramount importance in order to achieve an effective and reliable emergency response system. In the literature a lot of studies existed which focused on the Emergency Medical Services (EMS) and ambulance location, peleg and Pliskin (2004), Sakaklı (2006), Pell etal, (2001), Cromley and Wei (2011) and Gümüş etal (2006).

Fire is defined as an uncontrolled burning. It is not possible to avoid fires completely; however, the harm and damage caused by fires can be reduced if it can be taken under control at the initial stage and effective fire management. The protection of people, property and the environment from fire has long been a major concern in urban (and rural) areas (Murray, 2013). There are few types of research areas about fire management in the literature. One of the research areas is related to fire station location, (Revelle and Snyder 1995; Xin etal, 2000) Some studies about the location of fire stations were reported by; Plane and Hendrick (1977), Schilling et al. (1980), Badri et al. (1998), Habibi et al. (2008), Yang et al. (2007), Chevalier et al. (2012), Challands (2010), Catay (2011), Nisanci et al. (2012) and Murray (2013).

This study presents an evaluation of the locations of existing medical emergency and fire stations in relation to the location of emergency calls and response time coverage area using network analysis components, service area analysis and location allocation analysis. In addition the process of locating new stations using the Geographic Information Systems (GIS) is determined.

RESPONSE TIME and COVERAGE AREA

In a medical emergency or fire, rescue case response time is a crucial parameter to measure the quality of the service. When dealing with the people involved in an emergency event the EMS personnel focus on cardiac, vascular, respiratory, trauma, and other clinical factors. Although many factors determine the quality of EMS, response time is an important EMS industry benchmark. At the same time the main purpose of the fire and rescue services should be to reduce the damage and injuries that can result from a fire and rescue event. According to the NFPA "where feasible an early, aggressive, and offensive primary interior attack on a working fire is usually the most effective strategy to reduce loss of lives and property damage" (NFPA, 2010). When a fire is not contained in a single room or floor it develops rapidly into flashover phase, flashover time ranges from 5 minutes to 30 minutes (Kerber, 2012).

The response time is a critical component in the control and mitigation of an emergency incident (Hacıoğlu, 2010). The response time is the manageable segment of time within the entire sequence, it is includes alarm answering time, alarm processing time, turnout time, travel time and initiating action/intervention time (NFPA, 2010). In an emergency call the major factor is travel time, and travel time is affected by various factors; such as traffic volume, average travel speed, driver habits, road networks (main roads, residential roads), time of day (rush hour vs. non-rush hour), the season, and the location of the incident. Most of the factors affecting travel time cannot be controlled, but determining the best locations of medical emergency stations and fire stations for a particular area could reduce the response time.

The ambulance industry has suggested that emergent ambulance responses meet a response time criterion of ≤ 8 mins for at least 90% of all calls (Pons and, Markovchick, 2002). Pell et al (2001) calculated that a reduction in response time from 14 mins to 8 mins in 90% of all calls would increase survival following cardiac arrest from 6% to 8%. Response time is one of the most important indicators of preventing the damages and injuries caused by fire as in emergency cases. According to the NFPA after 8 minutes the fire starts to extend outside the room without sprinklers where it began (NFPA, 2010). Table 1 shows some response time criteria in the literature. In this study 8-minute response time was used.

Table 1. Studies on response time and average speed

Reference	**Response Time (min.)**	**Speed**
Stiegel 2004	10	----
Yang et al. 2007	5 to 8	60 mph
Habibi et al. 2008	3 to 5	40 km/h
NFPA, 2010	2 to 4	----
Catay, 2011	5 to 8	40 km/h
Chevalier et al. 2012	8	15 - 80 km/h
Nisanci et al. 2012	3, 5, 7	45 km/h
Murray, 2013	9	----

Average Speed

Travel time is the major factor which affect the response time. But, travel time is affected by various factors; such as traffic volume, driver habits, quality of road networks, etc. Average travel speed is one of the most important factors which affect the travel time. In this study average speed of the different type of roads were determined using vehicle trace system data. The vehicle trace systems collect the position, speed, maximum speed, driver name of the vehicles etc. Samsun Fire Department vehicle tracking data were collected and recorded periodically. Average speeds were determined using three months vehicle tracking data for four types of road; main road, street, branch road and alley. The average speeds of the fire and rescue vehicles were calculated as 40, 30, 25 and 15 km/h respectively and 50, 37.5, 31.25, 18,25 km/h were determined for the medical emergency system.

CASE STUDY

This study was undertaken in Samsun city, which consists of the three districts; Atakum, İlkadım and Canik (16789 ha) for the medical emergency cases and four districts; Atakum, İlkadım, Canik and Tekkeköy (28151 ha) for the fire and rescue cases (Fig. 1). The smallest administrative unit in the current study is the quarter. All the quarters belonging to the four districts were included in the study; however, the villages were excluded because of their separate locations, low population and low case rates.

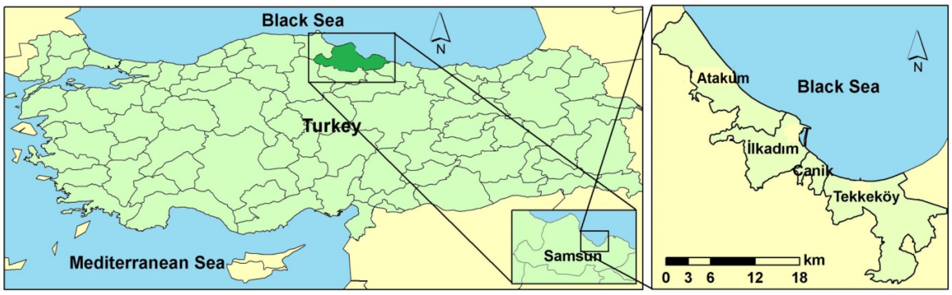

Fig. 1. The study area

Medical emergency cases

This study was included nine ambulance stations and 11506 emergency calls made in the Samsun provincial centre in 2009. The air ambulance was not part of this study. Detailed address data (i.e. local district and street) were obtained for all emergency ambulance callout locations. The positional data of the ambulance stations and emergency calls were also digitized (Fig. 2) and uploaded into the ArcGIS 10.1 software and evaluated together according to the response time coverage area. In the analysis phases of this study medical emergency cases evaluated using service area analysis.

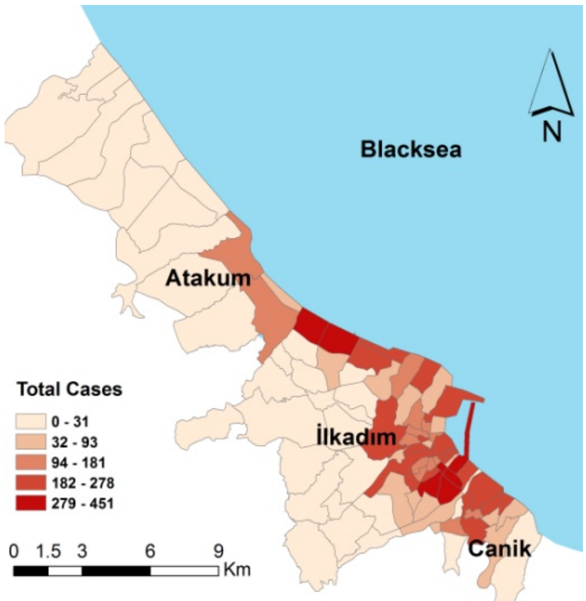

Fig. 2. Emergency medical cases, Atakum, İlkadım, Canik Districts

The response time is include alarm answering time, alarm processing time, turnout time, travel time and initiating action/intervention time. In this study alarm answering time, alarm processing time, turnout time was accepted two minutes and travel time is accepted five minutes, last one minute was taken by the activities at the scene. Average speeds were determined for four types of road; main road, street, branch road and alley. It was mentioned above the average speeds of the medical emergency vehicles was determined and all the average speeds were entered attribute data of this type of road for using in service area analysis. Service area analysis which is a network analysis tool was used to determine the coverage area of fire stations.

In the study area cases rates were different according to the population density of the quarters. Most of the population is concentrated in the central region of the İlkadım district and the coastal region of the Atakum district, according to the Turkish Statistical Institute (2014). In this study service area analysis was applied. Existing nine ambulance stations were cover a total a total of the 28.4% of study area and 81% of all cases according to 8-minute response time (5-minute travel time) coverage area (Fig. 3). According to the 11-minute response time (8-minute travel time) existing nine ambulance stations were cover a total of 46.7% of the study area, and 87.5% of all cases in the study area (Fig.4). Table 2 was present the total covered area and covered cases according to the existing medical emergency stations in the study area.

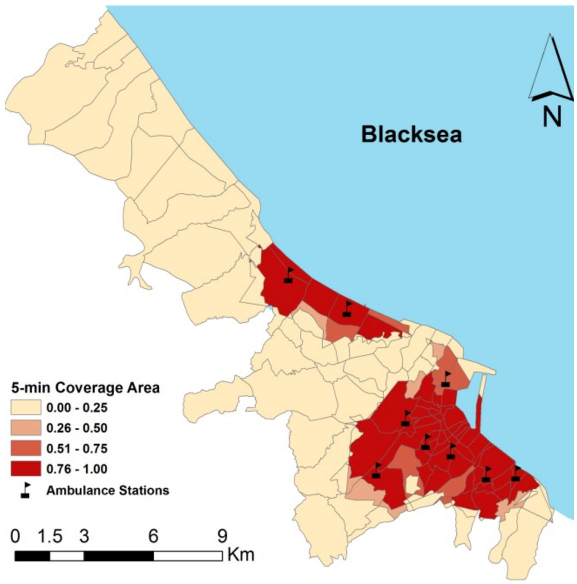

Fig. 3. 5-min travel time coverage area

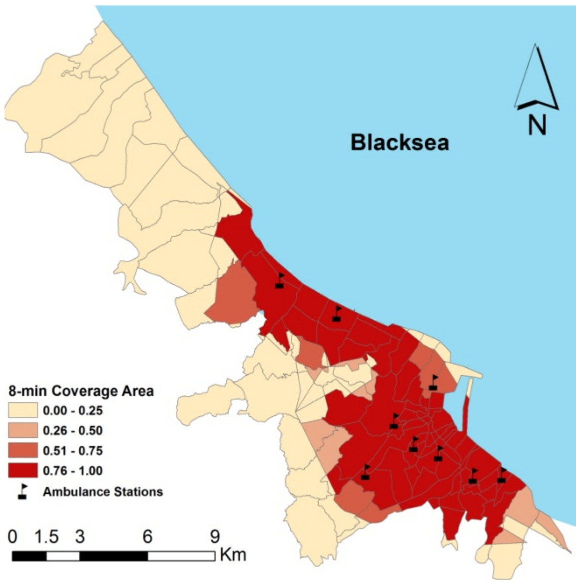

Fig. 4. 8-min travel time coverage area

Table 2: Total covered area and covered cases in the study area

Travel Time	Total area	Total cases	Covered area		Covered Cases	
			ha	ratio	cases	ratio
5-minute	16789	11509	4759	28.4	9286	81.0
8-minute	16789	11509	7845	46.7	10064	87.5

Fire and Rescue Cases

In the study area 1014 fire and rescue cases were recorded by the Samsun Metropolitan Municipality Fire Service Department between January 01, 2013 and December 31, 2013. There were three fire stations in the study area (Fig. 4), one main station in İlkadım district, and two substations in the Atakum and Tekkeköy districts. The locations of fire stations and all fire and rescue cases were digitized and uploaded into ArcGIS 10.0 software and then evaluated together according to the determined response time coverage area.

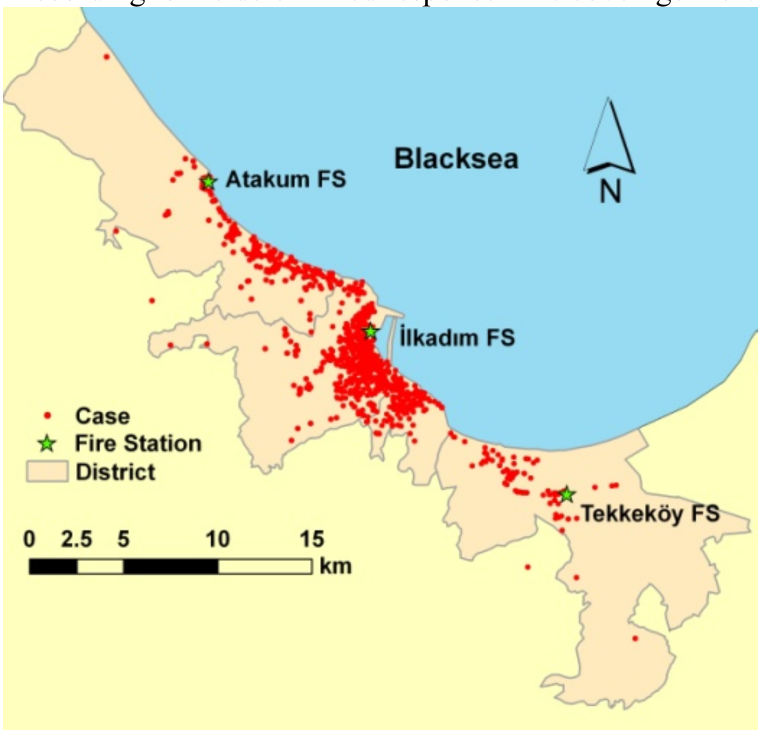

Fig. 5. Fire stations in the study area

Table 2. Fire and rescue cases

District	Area (ha)	Population	People per ha	Cases	Cases Rate
Atakum	9,265	149,226	16.10	201	19.82
İlkadım	6,128	312,248	50.95	572	56.41
Canik	1,414	93,721	66.28	158	15.58
Tekkeköy	11,344	51,124	4.50	83	8.18
Total	28,151	605,319		1014	

In the study area all districts have different population and population densities (Table 2) and this is the same situation in the quarters, consequently the fire and rescue cases were concentrated in particular region, central Ilkadım and coastal Atakum (Fig. 5).

Response time was determined to be 8-minute on the basis of the literature presented in Table 1. The travel time was determined as five minutes as medical emergency cases. As it mentioned above that the average speed for fire and rescue vehicles was determined using Samsun Fire Department vehicle tracking system data. The average speeds of the fire and rescue vehicles in different type of roads are calculated as 40, 30, 25 and 15 km/h, and all the average speeds were entered attribute data of this type of road for using in service area analysis. Service area analysis which is a network analysis tool was used to determine the coverage area of fire stations.

In this study according to the 8-minute response time area (5-minute travel time), a total of 372 (36.7%) cases were covered by existing three fire stations (Fig. 6). İlkadım station covered 332 (32.7%) cases, Atakum station covered 23 (2.3%) cases and Tekkeköy station covered 17 (1.7%) cases.

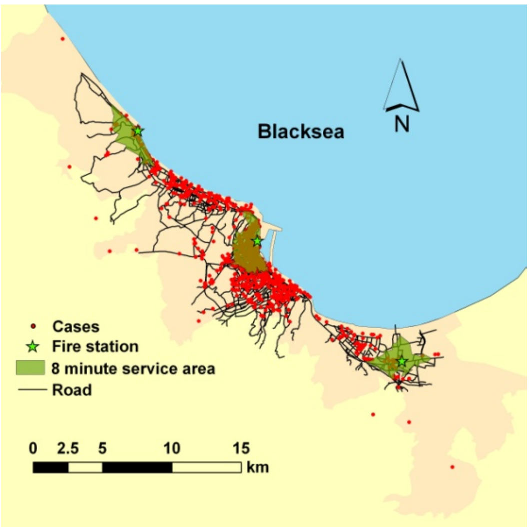

Fig. 6: 5-min travel time coverage area

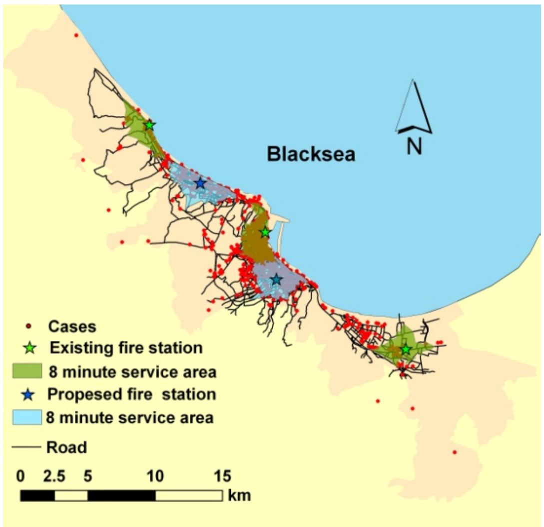

Fig. 7: 8-min travel time coverage area

In the current study area one main and two sub fire stations existed and a total of 372 cases were covered by three stations in 8-minute response time (5-minute travel time). In the study area a total of 642 fire and rescues cases were outside of the 8-minute coverage area of all the station. Thus, new fire and rescue stations were needed for an effective fire and rescue management, response to this need two locations were proposed based on uncovered cases according to the 8-minute coverage area. After determining the location of two new proposed stations, the total five stations covered a total of the 727 (71.7%) fire and rescue cases (Fig. 7) according to the 8-minute response time in the study area (Table 3). The proposed Station located in İlkadım covered 315 (31.1%) cases, 85 of which were from within İlkadım station coverage area, and the proposed Station located in Atakum covered 125 (12.3%) cases.

RESULTS and CONCLUSIONS

The primary goal of this study was to evaluate the coverage area of the existing medical emergency and fire stations and to determine the need for new stations according to the response time approach which was determined from the previous work in the literature. According to the service area analysis in the existing medical emergency stations is cover 81% of all cases according to 8-minute response time (5-minute travel time) coverage area and any changing in the location of the existing stations isn't recommended in the near future.

The analysis of the location of fire and rescue stations, any changing in the location of the existing stations isn't recommended, but two new fire and rescue stations have been proposed taking into consideration the cost of investment. However, similar studies should be performed again in the long term to consider the future population increase, new settlement areas, new industrial areas and new main roads.

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MANAGEMENT OF NATURAL RISKS AND DISASTERS IN A RIVER BASIN WITHIN THE NEW CADASTRE CONCEPT

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ABSTRACT

Multi-hazard risk analysis and land use planning based in multi-temporal and regional studies of geo-information compiled and developed by national agencies are to be managed locally to warn of the likelihood of an event and to focus the general situation of the most vulnerable areas. This concept integrates data available of climate change, land, social and economic indexes, risk and vulnerability, as well as disaster scenarios, to create a unique database to be used in selecting, validating, structuring and standardizing multi-hazard information in Spatial Data Infrastructures at municipal level, to improve the organizations responsible for land use planning, risk and disaster management. Integrated management within the Pacific river basins in Andean countries is still responsibility of multi-level organizations that have different land administration models for urban and rural areas. The ISO 19152, Land Administration Domain Model, LADM standard and the new Social Tenure Domain Model, STDM under construction, tender the ability to create a standard for cadastre within a river basin, with a minimum of items including the multi-hazard condition, in the "rights" component related to parcels, together with restrictions and responsibilities, to explode in a homogeneous, effective and timely manner, the land use planning, the capacity building, the risk management and decision making process. This geographic integration may propose a new different administrative political organization and divisions based on watersheds, or instead, encourage the use of legal mechanisms for joint management as in the case of the commonwealth, but in this case, based in a common cadastral model. The major threats, risks as well as restrictions and responsibilities on vulnerable parcels considered in developing the model are presented in a case study that describes the strong relationship of land use, cadastre and disaster protection.

Key words: cadastre, LADM, river basin, risk

RESUMEN

El análisis de riesgo multi-amenaza y el ordenamiento territorial basados en estudios multi-temporales y regionales de geoinformación compilada y desarrollada en los organismos nacionales deben ser gestionados a nivel local para advertir sobre la probabilidad de un evento y enfocar la situación general de las áreas más vulnerables. Este concepto integra los datos disponibles sobre el cambio climático, la tierra, los índices sociales y económicos, el riesgo y la vulnerabilidad, así como escenarios de desastre, para crear una base de datos única que sea útil en la selección, validación, estructuración y estandarización de la información de las múltiples amenazas en Infraestructuras de Datos Espaciales a nivel municipal, que permitan mejorar la gestión de las organizaciones responsables de la planificación del uso del suelo, el riesgo y manejo de desastres. La gestión integrada de las cuencas de los ríos del Pacífico en los países andinos sigue siendo responsabilidad de varias organizaciones multi-nivel que tienen diferentes modelos de administración de la tierra para las zonas urbanas y rurales. La ISO 19152, Modelo en el Dominio de Administración de Tierras, LADM y el nuevo Modelo en el Dominio de la Tenencia Social, STDM en construcción, brindan la posibilidad de crear un estándar para los catastros dentro de una cuenca hidrográfica, con un mínimo de elementos que incluyen, entre otros, la condición de multi-amenaza en el componente de "derechos" en su relación con los predios, junto con las restricciones y responsabilidades para administrar de una manera homogénea, efectiva y oportuna, la planificación del uso del suelo, el desarrollo de capacidades locales, la gestión del riesgo y la toma de decisiones. Esta integración geográfica puede proponer una nueva organización y división político administrativa diferente sobre la base de las cuencas hidrográficas, o en su lugar, fomentar el uso de los mecanismos legales para la gestión conjunta como en el caso de la mancomunidad, con base en un modelo catastral común. Las principales amenazas, riesgos, así como las restricciones y responsabilidades sobre los predios vulnerables considerados en el desarrollo del modelo se presentan en un caso de estudio que describe la fuerte relación de uso de la tierra, catastro y protección contra desastres.

INTRODUCTION

Land administration plans and decision-making processes currently do not consider the analysis of multi-hazard and risk in land use planning or environmental protection integrated into a single system; consequently when an event occurs, government and citizens suffer human and economic losses which have not been foreseen or quantified.

ISO 19152, Land Administration Domain Model, LADM considers the elements of basic geoinformation (including water, land, and the elements above and under the earth´s surface) in a concept that contains: *parties* (persons and organizations); *rights*, responsibilities and restrictions; *legal objects* (parcels, constructions and network services); *spatial objects* (topography) and *spatial representations* (geometry and topology). It provides a terminology on land administration and allows combining information from different sources and themes like in the present case referred to multi-hazard and risk.

Some models were developed (C. Aubrecht, et. al., 2012) for a multi-level geoinformation inventory of people and their interests in land and risk, starting from global to local scales and urban development. These models allow to including cadastre information in a land use planning system integrated with risk exposed zones at local level.

Ecuadorean Constitution of 2008 states that planning is a fundamental element of territorial development and it will be obligatory at all levels of decentralized autonomous governments, GAD. Jurisdiction of territorial planning and land administration must be coordinated within national, provincial, cantonal and parish levels. Art. 244 states that two or more provinces with territorial continuity can create autonomous regions; interregional balance, historical and cultural affinity, ecological complementariness and integrated basin management will be seek. At present, Ecuadorean administration is divided in 9 Planning Zones, 24 Provinces and 221 municipalities (cantons).

Using CRED database information (Guha-Sapir D, Hoyois Ph.Hoyois Ph., Below. R., 2014), natural disasters that caused most damage in Ecuador (human and economic losses) are flooding (42%), earthquakes (41%), landslides (13%) and volcanic activity (4%). This study will focus only in flooding, and volcanic activity affecting land cover, roads and educational and health facilities. Afterwards, it will link this multi-hazard risk analysis of Esmeraldas river basin with cadastral parcels involved, according to ISO 19152 LADM. But, because the lack of municipal cadastral parcel information, the block (manzana) level provided by the National Institute of Statistics and Census (INEC, 2010) will be used in this case.

The standardization of municipal cadastral information systems allows having uniform and homogeneous land administration data regardless of the existing administrative boundary between two neighbouring jurisdictions. This unified model makes decision-making uniform, timely, consistent and efficient in all administrations managing the watershed.

METHODOLOGY

A review of the ISO 19152 LADM standard and the ability to couple it with the risk variable was performed by analyzing the legal basis that allows its modelling and implementation. In this context, the methodological process (Fig. 1) starts by analysing, evaluating and downloading geoinformation presented through the Geoportal of the National Information System, NIS that manages the National Ecuadorean Spatial Data Infrastructure (CONAGE, 2010) to define the hazards to be analysed and the exposed areas. Then, the cadastral elements exposed (in this case the blocks because the lack of parcel data) to the volcanic activity and flooding hazard must be analysed in dept at local level and finally a conceptual model to integrate ISO 19152 LADM with the variable multi-hazard is proposed.

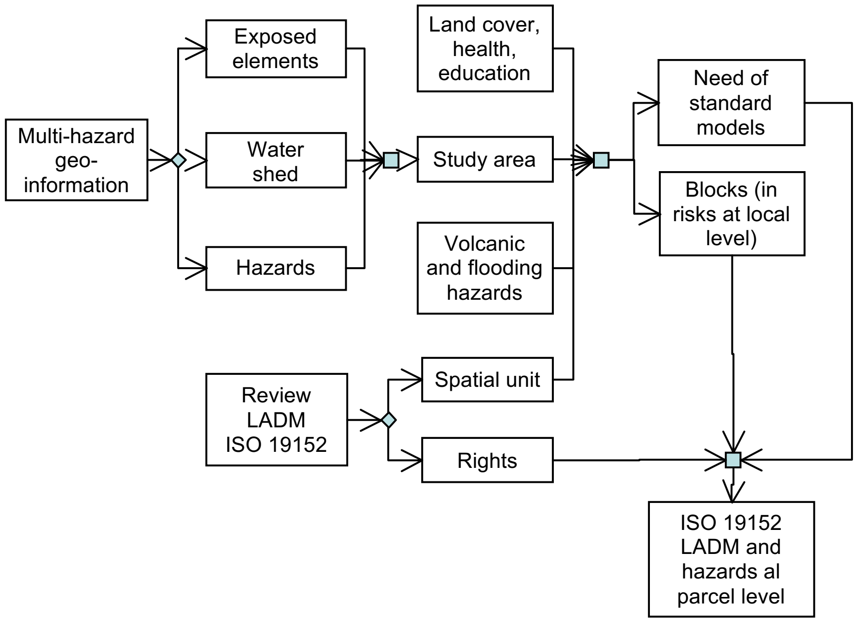

Fig. 1. Methodology to integrate multi-hazard analysis and ISO 19152 LADM

ANALYSIS AND DISCUSSION

The study area is the Esmeraldas Basin Watershed located north-west of the Ecuadorian mainland, where exposed areas are grouped in three categories: 1) natural areas: páramo, wilderness, natural forest, shrub vegetation, natural grass; 2) productive with human intervention areas: pastures, harvested forest, oil palm, short-cycle crops, tropical tree crops, and, 3) urban areas. Roads as linear elements; health and school units as point elements are also studied. The hazards analysed were only the volcanic and flooding, together with the exposed elements, Table 1. The official information was downloaded from the NSI.

Table 1. Exposed elements in the Esmeraldas River Basin

Exposed elements	Volcanic hazard	Flooding hazard
Natural areas	33%	18%
Productive with human intervention areas	63%	79%
Urban areas	1%	1%
Other areas	3%	2%
Roads	26 sectors	28 sectors
Health centres	78	84
Educational centres	634	711

When considering the Esmeraldas river basin as the unit of study and risk management, the joint intervention of municipal jurisdictions is essential. The need of standardization and compatibility among municipal cadastral systems in conurbations (continuous of urban areas and potential areas for urban development belonging to different municipalities) is the first problem. This is the case of the municipalities of Quito - Rumiñahui and increasing Mejia – Rumiñahui. They have different models of cadastre, making impossible an integrated risk management against natural events. Thus, the need to generate a model with minimum common standards for the development of cadastral systems and land use plans of the three municipalities is justified.

The Ecuadorean Constitutional mandate and the Código Orgánico de Organización Territorial Autonomía y Descentralización, COOTAD 2009, establish that the "mancomunidad/common wealth" is the legal instrument that allows integrated management of contiguous municipalities and in this case those that are part of the Esmeraldas River Watershed. This instrument can be used for standardization, geoinformation generation, analysis, research, modeling, training, joint decision-making and the creation of cadastral systems linked with multi-hazard data in a risk management system. The objective is to design a common model implementing the ISO 19152 LADM standard to unify the existent municipal cadastres to plan and monitor the use of land and resources at parcel level, considering the responsibilities and restrictions to the land under the existing risk, in addition to the rights and corresponding valuation.

A model for the relationship between the Infrastructure for Spatial Information in the European Community, INSPIRE Annex and ISO 19152 LADM has been proposed by Oosterom and compares the elements needed for land use planning. In Ecuador, a methodological guide has been prepared (Senplades, 2011) to standardize plans of territorial ordinance which contains some similar elements than those of INSPIRE, but grouped in systems (environmental, economic, social, energy, mobility, connectivity, human). The concepts proposed in 4D research project (ITC, 2013), and the Changes Project (European Community, 2012), groups the same elements but in terms of climate change, land and socio economy, risk and vulnerability, and development scenarios. Integrating all this information in just one database will allow: 1) to select, validate, structure and standardize multi hazard information in a web geodatabase; 2) to associate land parcels to hazard, risk and main influence areas at local level, and; 3) to model and simulate events for different hazards and risk types using ISO standards for geo information in order to integrate them in a Cadastral Data Infrastructure in terms of multi-hazard, multi-risk and multi-vulnerability.

The survey conducted by the Ministerio de Desarrollo Urbano y Vivienda, MIDUVI in 2012, highlights that only the 22% of 221 Ecuadorean municipalities have their cadastres based in one kind of GIS but still in two different systems (one for rural and one for urban areas). In an isolated system the Property Registry deals with tenure; however a new mandate states that it must be under the municipalities. ISO 19152 LADM proposes a system based in Cadastre 2014 concept integrating in one system three basic entities: subjects, land parcels and rights. The model to associate a land parcel as element of an integrated cadastre of urban and rural areas includes the interests as rights, restrictions and responsibilities. Then, risk within a cadastral system provides rights, restrictions and responsibilities on the land parcel together with Property Register Agency, Fig. 2.

Fig. 2. Relationship object – rights – subject under Cadastre 2014 and ISO 19152 LADM concept

The *"legal object"* or parcel in traditional cadastral cartography is the geometric representation of the parcel and its buildings, boundaries and area, answering the question Where is it?. The entity is represented by spatial objects of the land parcel (spatial units) and its habitat by means of spatial objects and other representations like digital terrain model, hydrographic network, transportation network, geographic names, national and international boundaries, postal codes, services network, land cover, land use, buildings, natural (seismic, tectonic, volcanic, flooding, landslides) and anthropogenic hazards. This cadastral information is used to know the value, answering the question: How much does it cost?

The *"spatial object"* and the legal object with their components are considered part of the habitat and housing definitions. The *"rights"* or the legal parcel information contain rights, responsibilities, restrictions and tenure. Answers the question: What is the tenure?. Providing legal information of the relationship subject – parcel by rights (environmental and multi-hazard restrictions and responsibilities, among others). The *"subject"* is the entity that has the relationship with the legal object; this element has the attributes to describe it as name, ID number, address, etc., answering the question: Who is the subject related to the parcel?

For the concept based in object - rights – subject, work is necessary to integrate cadastral systems of urban and rural areas as well as records of the property that at present are separated, see Fig. 3(a), in one unique municipal system. The ISO 19152 LADM standard in its modularity considers three elements: people, rights and properties into a single model as shown in Fig. 3(b) and integrates through the parcel, all existing space objects in a jurisdiction including water, land and the elements above and below the earth's surface.

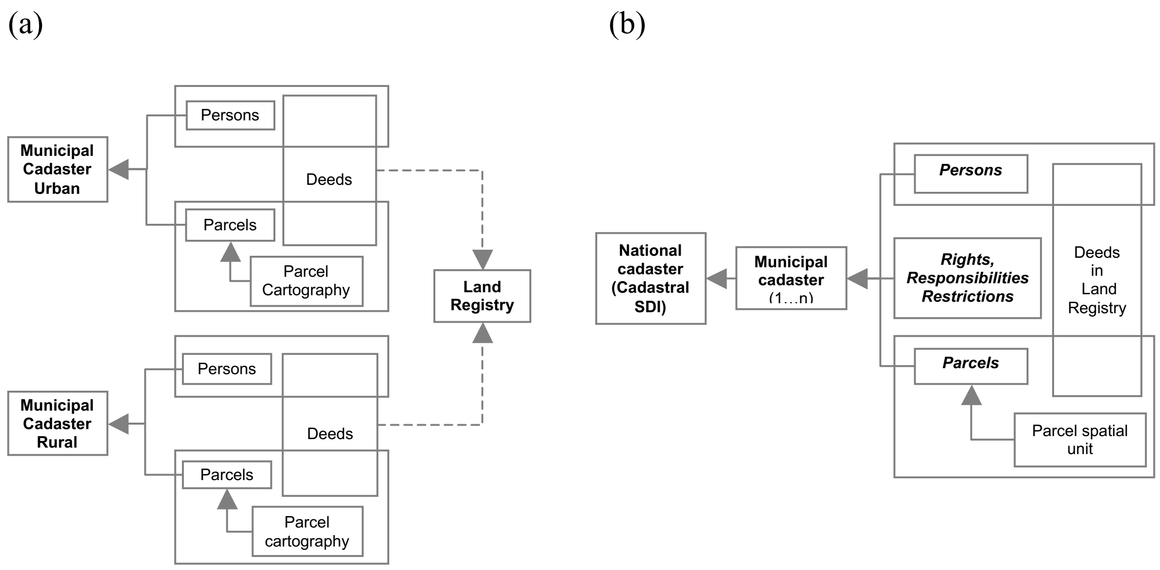

Fig. 3. Model of current cadastral systems (a) and, model based on ISO 19152 LADM (b)

The subject module or Persons are natural and organizations to whom is assigned a portion of the earth's surface; module Rights, Responsibilities and Restrictions refers to all legal information in terms of a relationship with the person, not only from the point of view of ownership but with the potential use, land use, the multi-hazard, environment; module of legal objects (land, buildings and service networks) is made with the corresponding spatial objects (topography), spatial representations (property space) and the basic administrative units.

The information generated in this system is standardized and maintained in the respective databases, becoming the center of the Municipal Cadastral System. In the case of a national system, this information easily through a distributed system allows the access to certain required municipal information distributed transparently for government decision-making and use of the citizens. The modernization of services and processes to improve the efficiency and effectiveness of the land administration modelo, requires minimal computational mechanisms.

The model to associate the premises as cadastral elements with risk elements is presented in Fig. 4 with a unified register for rural and urban areas including information of Land Registry. The relationship of risk is articulated in terms of tenure, restrictions and responsibilities. Any form of tenure may have beyond their own rights, responsibilities and restrictions under the optimum land use, risk or environmental protection. The cadastral model, under this concept, allows proper risk management and integrated planning as well as land use in a standardized Land Administration System in all municipalities that are part of the watershed.

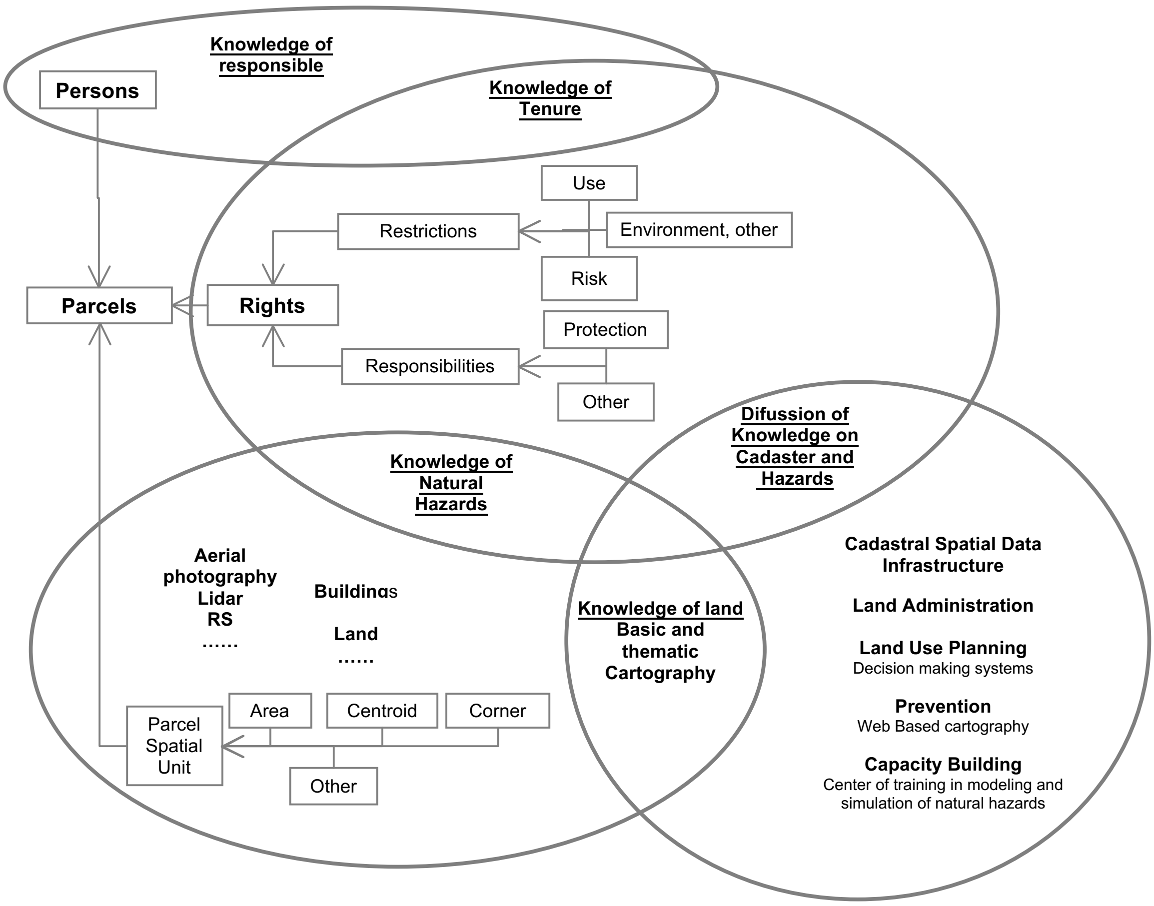

Fig. 4. Relationship of a risk management system integrated with a Land Administration System in ISO 19152, LADM.

CONCLUSIONS AND FURTHER REMARKS

The multi-risk analysis has no administrative boundaries. Its integrated management can generate a new proposal for administrative-political organization based on watersheds or encourage the use of legal mechanisms for joint management as in the case of the commonwealth. For this it is necessary to standardize a municipal cadastre model to incorporate the relevant variables to natural hazards in the basin.

Standardization, validation and definition of concepts related to integrated risk management in a system of territorial administration under ISO 19152 LADM are needed in:

- The type of tenure, land use, rights, responsibilities and restrictions in a parcel.
- The data model of integrated rural and urban cadastral system.
- The model of a system for spatial analysis and simulation that allows the training of those involved in risk management.
- Determining the economic valuation of potential losses of natural areas, disturbed areas of production and urban areas in the event of a disaster, with information on the proposed cadastral system.

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