3D Cadastre in Argentina: Maps and Future Perspectives

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SUMMARY

Argentina is a federation of 23 provinces, plus the Federal Capital District (City of Buenos Aires). The agencies responsible for land registration and for cadastral survey depend on provincial government. Cadastral organizations are related to different ministries depending on the specific province. Cadastral systems cover the following aspects: legal (properties and possession), economic (land valuation and land taxation support), and geometric (surveying maps). Since each province has its own cadastre, the emphasis in the roles mentioned above vary among them. The role of the provincial cadastre is complemented mainly by municipal cadastres according to the provincial organization and development.

Cadastral maps cover urban and rural areas, showing the administrative and parcel boundaries, constructions and complementary improvements, as well as roads and streets. The main shortcomings of the Argentinian cadastre are the lack of georeferenced data; the spatial extent of rights is not available in the cadastral map.

The multipurpose vision of cadastre is still very incipient throughout the country and probably that is the reason why the Argentinean Spatial Data Infrastructure (IDERA) has not yet been implemented.

This paper brings dispositions and examples of horizontal properties maps of some provinces of Argentina. As a conclusion, the paper proposes an appropriate 3D model according to the current legislation.

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1. INTRODUCTION

The Argentine Republic does not have a national cadastre, as do most of the other Latin American countries. Each province is free to organize its own system of land information, as stipulated explicitly in the National Constitution. Therefore, the Argentine cadastral structure is composed of provincial and municipal cadastres with different levels of sophistication and integration across the country. Public information about the land is obtained through the cadastral data, complemented with the records of the Registries of Deeds (*Registros de la Propiedad Inmueble*), which are provincial institutions.

Given the diversity of criteria used to promote, coordinate and guide the job of creating a countrywide territorial cadastre, the provinces created in 1958 the Federal Cadastral Council (*Consejo Federal de Catastro*) with the goal of implementing, promoting and coordinating research and consulting activities, and contributing to the creation and development of a cadastre with a territorial information system based on a multipurpose model. The Federal Cadastral Council was formally recognized by Law No. 26.209, Cadastral National Law, Chapter V, as a body composed of all the provincial cadastres and the cadastre of the Autonomous City of Buenos Aires, in order to meet the goals established by law.

Property rights in Argentina always have to relate to surface parcels; consequently, the ownership of real estate above and below the surface is always established on surface parcels. A parcel column can be divided in horizontal layers, which in turn can be subdivided into units according to the Horizontal Property Law. The resulting units can be considered as true 3D parcels and they are assigned a unique parcel number.

The horizontal property units are registered according to the dispositions of Law No. 13.512/1948 (Horizontal Property - PH), which recognizes within a complex building the following three dimensional parts: private ownership units, common areas with exclusive use by specific owner, and true common areas.

Each unit is assigned a unique parcel number, in a manner similar to other parcels according to urban law. For this, a true survey plan (not a building design document) is required. In this document, information is added in the form of cuts or slices. A set of cuts, used in some provinces, is used to obtain a volumetric impression. The provinces have their own rules for drawing the PH maps and one of the main tasks of this paper is to compile and describe some of them.

As in most other countries of the world, the parcel is the common registration unit for cadastres in Argentina. All land parcel division, unification, amalgamation, etc. must be registered within the cadastral organization. Horizontal property units (apartments, condominiums) are also registered.

With the objective of modernizing and improving the provincial systems, a new National Cadastre Law was published on January, 2007. It brought new and different dispositions, but

none of them applies specifically to 3D cadastre implementation. Until now, only 8 provinces have adapted their laws to the national one.

The cadastral legal framework is composed of the provincial laws, the municipal statutes and the Cadastral National Law, No. 26.209, enacted on January 18, 2007, that establishes a reference framework for the entire country.

In almost the entire provincial legislation, the cadastral unit is the parcel, which is consistent with the definitions adopted by the National Law. The parcels can have ownership title (*dominiales*), in which case they are permanently recorded in the cadastre, and may have a public or private owner; and/or they can be possessions (*posesiones*), whose tenants, in some jurisdictions, record them temporarily (until a judicial order grants them full title) and pay property taxes.

2. A HISTORY OF THE ARGENTINE CADASTRE

When the Spanish arrived in South America, they brought with them the system of public property records, inspired in Spanish legislation, which was codified in the Indies and Toro Laws (*Leyes de Indias y Toro*).

After the Argentine revolution, on May 25, 1810, part of the land that belonged to the Spanish Crown was transferred to public ownership, and there was a need to structure a system of public records in order to manage the national territory.

This process of institutional organization was slow, taking an important step on September 25, 1824, with the creation of the Topographic Commission of the Province of Buenos Aires (Comisión Topográfica de la Provincia de Buenos Aires), charged with assembling an information system from the provincial topographic map (this date is now remembered as the National Day of the Cadastre). Two years later, on June 26, 1826, a Government Decree transformed that Commission into the Department of Topography and Statistics, expanding its role. This new institution is considered one of the first civil cadastres in the world, after the Roman Census, and even preceded the famous Swiss cadastres of the cantons of Vaud (1826) and Geneva (1841) (Castagnino, 1967). This institution is considered the bedrock of the Argentine cadastre, as it contained all the survey blueprints, stored both graphically and in an alphanumeric database, reason for which June 26 is celebrated as the Day of Cartography.

In September of 1869, the Argentine Civil Code was enacted by Law No. 340, which entered into effect on January 1, 1871. The Code established a system of land titling and a procedure to acquire real estate, but did not mandate a registry system for the public recording of real estate transfers. The cadastres and registries were thus marginalized from the real estate market.

In this context, the provinces decided to create an administrative body to publicly record titles, and recognize it as the only form of acquiring property and defend it from third party claims.

In 1968, Law No. 17.711 introduces the obligation of perfecting the transfer of real estate by recording all transfers in the corresponding real estate registry (this signifies the public recording of the legal right to real estate) and the Registry Law No. 17.801 mandates real estate records.

In 1973, the Cadastral National Law No. 20.440 marked another historic milestone in land legislation in the Argentine Republic. This law established uniform procedures across the country, and even though it was written with the goal of supporting the public recording of real estate transactions, its effectiveness was truncated by Decree- Law No. 22.287 of 1980, which suspended practically all its articles.

The legislative vacuum left by the suspension ordered by Decree- Law No. 22.287 motivated the professional surveyor bodies, especially the Argentine Federation of Surveyors (*Federación Argentina de Agrimensores, or FADA*) and the CFC, to write and propose federal legislation for many years, until a consensus was reached for a proposed Cadastral Act. This bill, submitted by Senators José Luis Gioja and Eduardo and Brizuela del Moral, received approval in November of 2004 by the Senate, and was finally promulgated into law in January of 2007 as Law No. 26.209, known as the "Cadastral National Law", which complements the Civil Code.

This new law establishes a modern concept of the multipurpose cadastre, adapted to the present times and needs, elevating it as one of the main building blocks of the Spatial Data Infrastructure, and establishing a new outlook for the Argentine cadastre. This new law reaffirms the legal standing of the existing cadastral laws in the provinces which have them, and requires the use of the federal legislation to complement all local ordinances in those provinces that do not have one.

The National Law designates the provincial cadastres and the cadastre of the Autonomous City of Buenos Aires as administrative bodies in charge of territorial objects and keeping all public records of "legal territorial objects", either of public or private ownership, within its jurisdiction (Art. 1).

The same law defines the parcel as a cadastral unit: a representation of a continuous real estate territory identified by a polygonal boundary with one or more legal titles of possession, whose existence and essential elements are recorded in a cartographic document registered in the cadastral body (Art. 4). The essential elements of a parcel are a georeferenced location of the property, the restrictions on the parcel as defined by the legal clauses that created it, the linear, angular and area dimensions of the property, and – as complementary elements – its tax assessment and its boundaries (Art. 5).

Practically all the provincial laws have a definition of "cadastre" and "parcel" consistent with the Cadastre National Law; some have implemented changes and others are in the process of adapting their definitions. It is interesting to compare the conceptual and cartographic differences that still exist in each of these regional units.

The definitions expressed in Arts. 4 and 5 show the clear 2D concept of the Argentine cadastre. However, the definition of the real estate property in the Civil Code is spatial, and sets the conditions for creating a 3D cadastre for the entire country.

3. THE 3D CADASTRE IN ARGENTINA

This research over the interpretation of the current and future status of the 3D cadastre in Argentina was based on a questionnaire structured by the Working Group on 3D Cadastres, translated and adapted to the reality of the country. The document was distributed to all the members of the Federal Cadastral Council, which is composed of the Directors of the cadastres of the 23 Argentine provinces and the Federal Capital. There were received 5

complete responses which are considered a meaningful sample due to the geographic diversity of the provinces and their regulations which are analyzed below.

3.1 General/applicable 3D real world situations

All the responses were negative, that is, the officials confirm that the concept of the 3D parcel does not exist officially in Argentina. All the parcels are defined in 2D. This two-dimensional definition is consistent with the Cadastral National Law, Art. 4: "for the purposes of this Law, a parcel is a representation of a continuous real estate territory identified by a polygonal boundary with one or more legal titles of possession, whose existence and essential elements are recorded in a cartographic document kept in the cadastral body".

Even though the Civil Code refers to a "volumetric property" that is also bound by vertical surfaces, for the territorial cadastre, which is where the property is legally born, the boundaries are lines, that is, the projection of these surfaces over a map. The surfaces that define the natural boundaries of the parcels may be curved (e.g., a watershed, a riverbed, among others), while the anthropological limits (normally demarked with walls or fences) are vertical surfaces.

There is no detailed study yet on how to describe a 3D parcel; this is an area of research that should be prioritized, based on the TC211series of ISO standards.

The current law considers the spaces occupied by natural resources, such as underground water and mine deposits, to be territorial objects, and not parcels, which are defined in Art. 10: "The legal territorial objects which do not constitute parcels in accordance with Art. 5 of this Cadastral National Law will be established by surveys or other alternative methods that guarantee similar levels of precision, reliability and integrity as surveys established by the local legislation, and recorded before the cadastral body, in accordance with local legislation".

To this end, the regulations in effect for implementing and recording survey blueprints of the Territorial Cadastral and Information Service (*Servicio de Catastro e Información Territorial, or SCIT*) of the Province of Santa Fe stipulate: "The surveyor shall represent waterways, lakes and ponds, ravines, forests, communication links, conduits and other visible topographic irregularities located inside a parcel, over its boundaries or in its vicinity, using terrestrial surveys and/or extracting the information from cadastral and/or cartographic data". The three-dimensional representation is introduced in Paragraph b. of the same article: "To define the boundaries of waterways, lakes and ponds, a planar and altitude profile shall be drawn to show the position of the boundary of the parcel and the waterway, lake or pond".

While the territorial objects identified in Paragraph b. do not require coordinates or altitudes, other relevant objects do need to be referenced in the vertical dimension, as stipulated in Paragraph c.: "In the case of a river bank reestablished by an administrative ordinance, the following shall be added: date on which the height of the surface water was measured, height of the water and kilometer (location) of the waterway where it was measured; the coordinates of the river bank that were determined, the official coordinate(s) used and the applicable towpaths".

As for easements or restrictions to the property, the regulation transfers the responsibility of defining them to other institutions, as stipulated in Paragraph h.: "For properties abutting or crossed by canals, a report issued by the Ministry of Water, Public Services and the Environment must be enclosed showing the width of the affected area".

There have been isolated initiatives, although by no means irrelevant, to map the contaminated areas of the country (air, surface and underground contamination). As for the metrics used to represent them, although the contamination maps are not always compatible with the cadastral charts, it is common to find cartographic representations that superimpose both, in order to identify the affected areas. To reiterate, it is rare to find coordinates, levels, or the vertical dimension of a contamination plume in these documents, so we considered them to be 2D.

3.2 Infrastructure/utility networks

The responses obtained were mixed: while some jurisdictions show a 2D representation of the distribution of the public utility networks, others only have YES/NO fields in the cadastral alphanumeric database.

The public urban service utilities tend to have information systems that are more complete and updated than the official cadastres, although they follow the 2D tradition, representing their networks by lines without specifying coordinates or altitudes along the way.

Although the exchange of data between institutions is infrequent, the provinces with a Spatial Data Infrastructure (*Infraestructura de Datos Espaciales*, or IDE) have integrated the cadastral data with the information provided by utilities. Santa Fe's Spatial Data Infrastructure (IDESF) allows public queries of territorial information in http://www.idesf.santafe.gov.ar/, but this information is still in 2D.

Returning to Art. 31 of the Santa Fe regulations, Paragraph a. states: "in the case of electric conduits, if there is no easement map, the axis of the conduit must be shown in relationship to the parcel boundaries, together with the conduit parameters, if known. If there is a recorded easement map, the axis, areas of maximum and medium security indicated in the blueprint, and the actual axis surveyed by the professional must be indicated on the parcel".

We can conclude that – similar to the territorial parcels – the infrastructure networks do not have cadastres with geometric descriptions to pinpoint their precise identification. This is another subject that needs to be prioritized for investigation.

3.3 Construction/building units

The positive responses to the question about recording of buildings or constructions as 3D units are a consequence of the interpretation of the law which requires representations to be submitted in 2D, but specifying the height of each floor and referencing all vertical distances to the ground.

None of the responses received shows evidence of civil engineering records other than parcels. Bridges and tunnels are not recorded on the cadastral maps, nor is their value is assessed, and there is no evidence that the building or management companies have transferred the construction data to the cadastral body for integration. For that reason, at least in the jurisdictions that responded to the questionnaire, typically there are no descriptions of these objects.

In accordance with Art. 2 of the Horizontal Property Law No. 13.512, "each proprietor shall be the exclusive owner of his/her flat or apartment, and co-owner of the land and all other objects of common use or essential for maintaining security in the building. For that reason, the following are considered common ownership:

a. Foundations, load bearing walls, roofs, solar patios, portals, galleries and common lobbies, stairs, entrance doors, gardens;
b. Central service rooms and facilities, such as heating, hot or cold water, air conditioning, etc.;
c. The rooms for the caretaker and superintendent's apartment;
d. The walls or partitions between apartments;
e. The elevators, freight elevators, incinerators, and in general, all artifacts or other facilities for common benefit services. This list is not exhaustive.

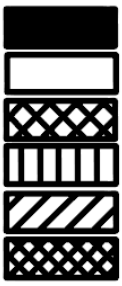
The basements and roof terraces are considered common areas unless otherwise noted.

From the lowest garage floor downwards, and from the building rooftop upwards, the property is also common, as stipulated in Art. 7 of the law: "The owner of the uppermost floor cannot construct new floors or additions without the consent of the owners of the other apartments; the owner of the first floor or floors below the surface cannot build constructions that affect the stability of the building, such as excavations, basements, etc. All new construction that affects the common areas cannot be realized without authorization given by all the owners.

As for the common property, Art. 8 states that the "the owners shall share the administrative costs and repair expenses for the common elements and assets of the building that are indispensable for maintaining its security, comfort and decorum, in proportion to the value of their apartments, unless otherwise noted.

From this it is possible to conclude that walls, floors, structures and roofs are common areas in the 2D representation and common spaces in the 3D concept. The phrase "that which is common limits the extent of exclusive ownership" is valid for the 2D concept of the current cadastre, but can be extended to the 3D vision.

In accordance with Decree No 18.734/49 and its amendments, introduced by Decree No 23.049/56, "the transfer of ownership or other real estate rights over apartments shall not be recorded in the public registries of deed unless there is an existing Co-ownership and Administration Statute, or this Statute is presented at the time the ownership is recorded. In other words, the ownership right cannot be created without a Co-ownership Statute which, in turn, depends on the existence of a cadastral blueprint, as stipulated in Art. 4: "In order to record a Co-ownership and Administration Statute, it must be submitted to the Registry of Deeds together with… a blueprint of the building presented on cloth and signed by a professional with a qualifying degree". The same article describes the features of the blueprint, stating that "…in that blueprint, the units shall be numbered consecutively and, starting on the bottom floor, shall include the dimensions and detailed description of each unit and the common areas of the building, identifying in color the areas of exclusive ownership". In this regard, different jurisdictions propose alternatives for representation of the parcels. In the province of Santa Fe, for example, the different uses of the building are represented with visual patterns in black and white, as shown in figure 1.



Partition Walls and/or Facade
Area of exclusive ownership
Area of common ownership and common use
Structural elements and conduits
Area of common ownership and exclusive use
Area of common ownership and exclusive use of certain units

Figure 1. The different uses of the building are represented with visual patterns in black and white

In Argentina, the parcels are generally referenced to urban elements, such as the corner of a city block, determined by the intersection of the building setback lines (line that separates the public from the private domain), fence posts, etc. However, some jurisdictions have started to implement absolute coordinates, such as the Province of Santa Fe, for example, where the survey blueprints of certain rural parcels larger than a given area must be georeferenced, and therefore have geodesic and two dimensional coordinates.

The X, Y coordinates of the cadastral databases is referenced to different points. In the Federal Capital of Buenos Aires and in the Province of Buenos Aires, the coordinates are local, referenced to a point located in the Flores Cathedral and the Province of La Pampa uses coordinates defined by the National Geographic Institute (*Instituto Geográfico Nacional*).

There is a strong tendency to adopt the POSGAR 2007 reference framework, as much for the cartography as for the geodesic network, in order to standardize land information not only for the provincial cadastres but also the federal system.

In practically all Argentine cadastres, the vertical distances of elevated objects are measured to the floor on which they are supported, and not identified with absolute heights or altitudes.

These representations basically follow two strategies:

1. Inclusion of a circular black and white symbol (figure 2), and at its side the vertical distance from the floor to a street level reference.
2. Representation of the height of the apartments (Z) in a horizontal property building using cross-sections and representation of the building façade. Figures 3 and 4 show examples from the province of Santa Fe and Tucuman, where 3D objects are represented and visualized with simple geometric drawings. In this case, it is possible to say that the drawing is a proto-3D representation, at least in buildings whose dimensions do not always coincide precisely with those of the parcel.

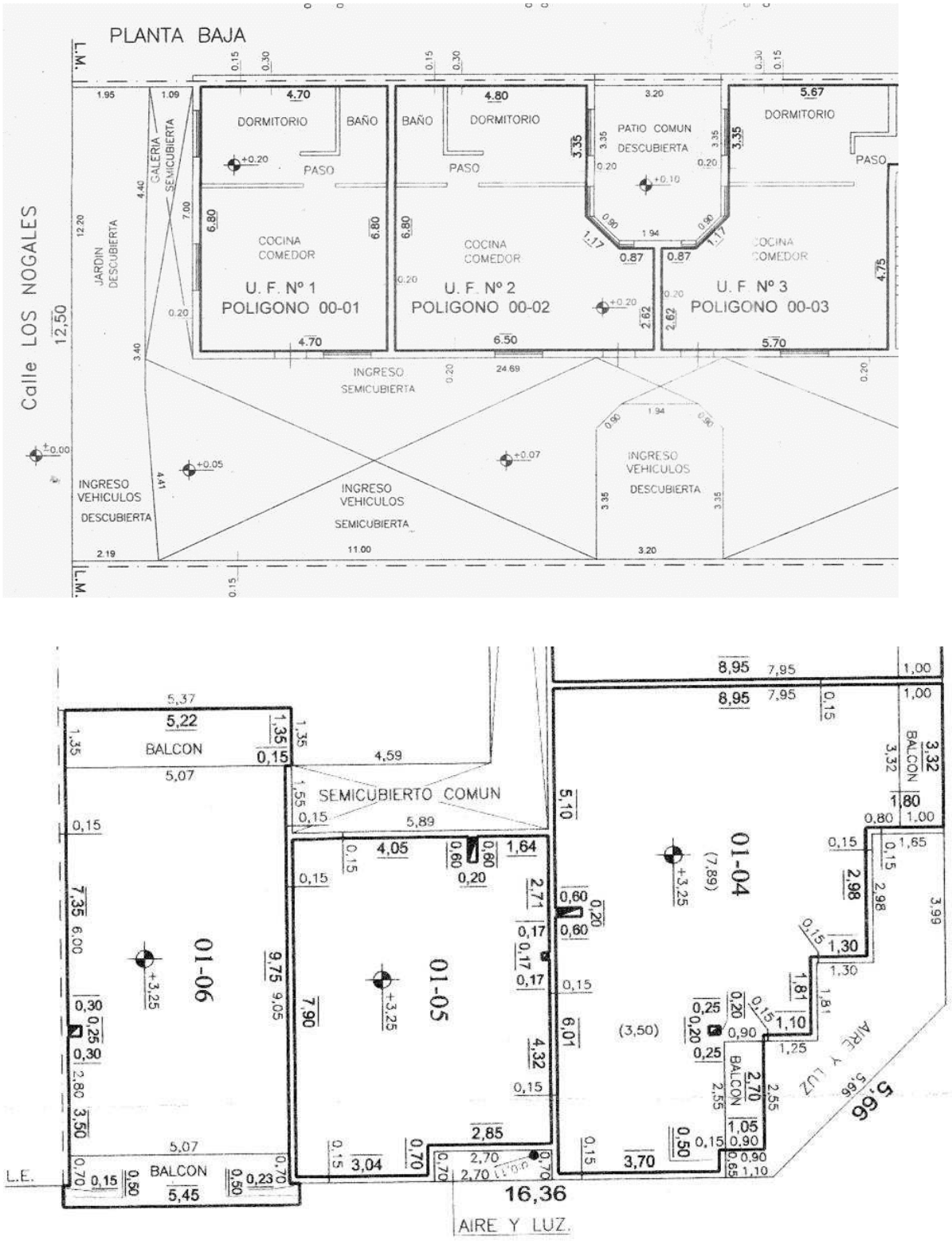


Figure 2. Example of survey blueprints of horizontal property from the provinces of Entre Ríos (first) and La Pampa (second)

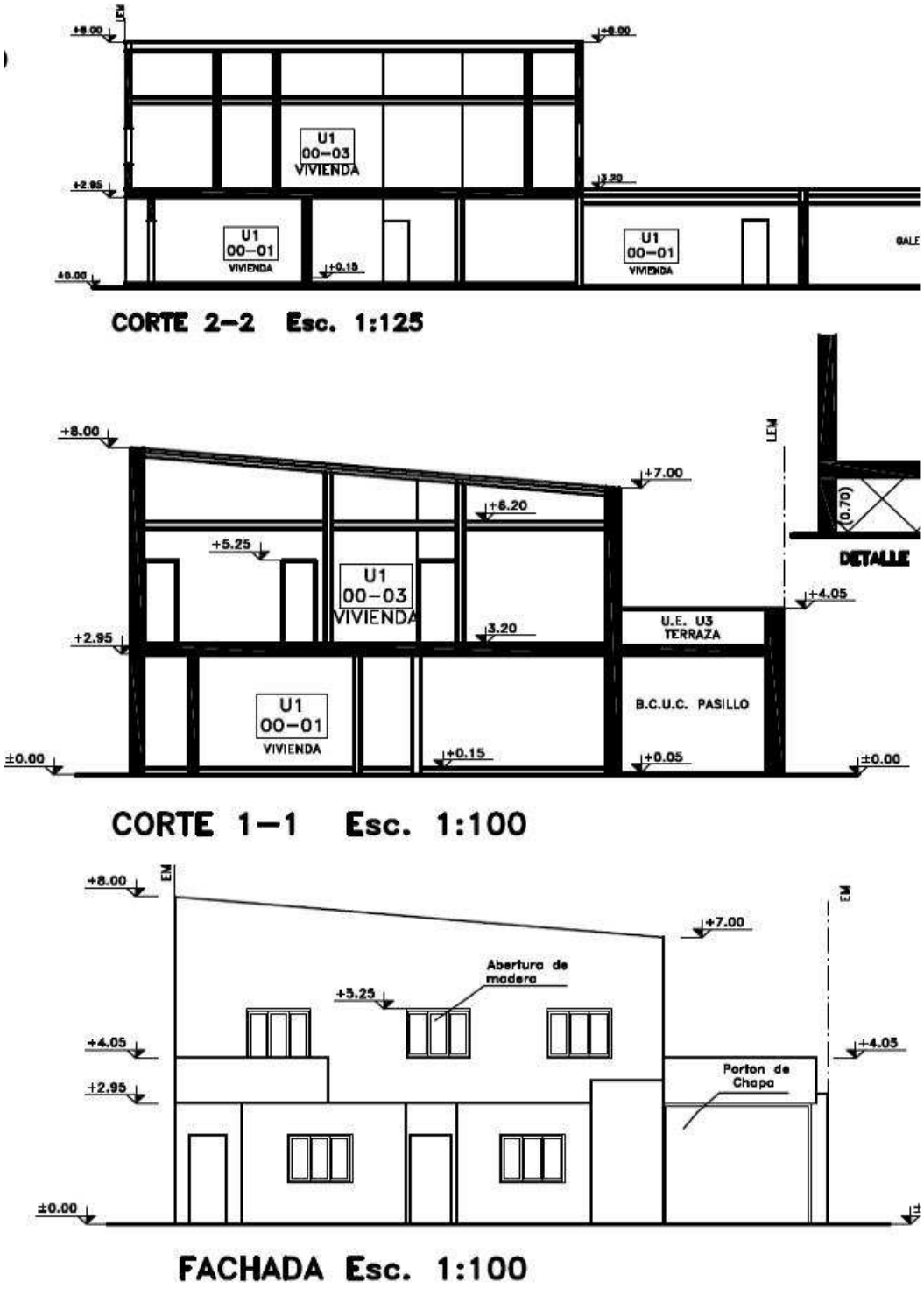


Figure 3. Facade and cross-sections with identification of heights relative to the floor, in the of Santa Fe blueprints

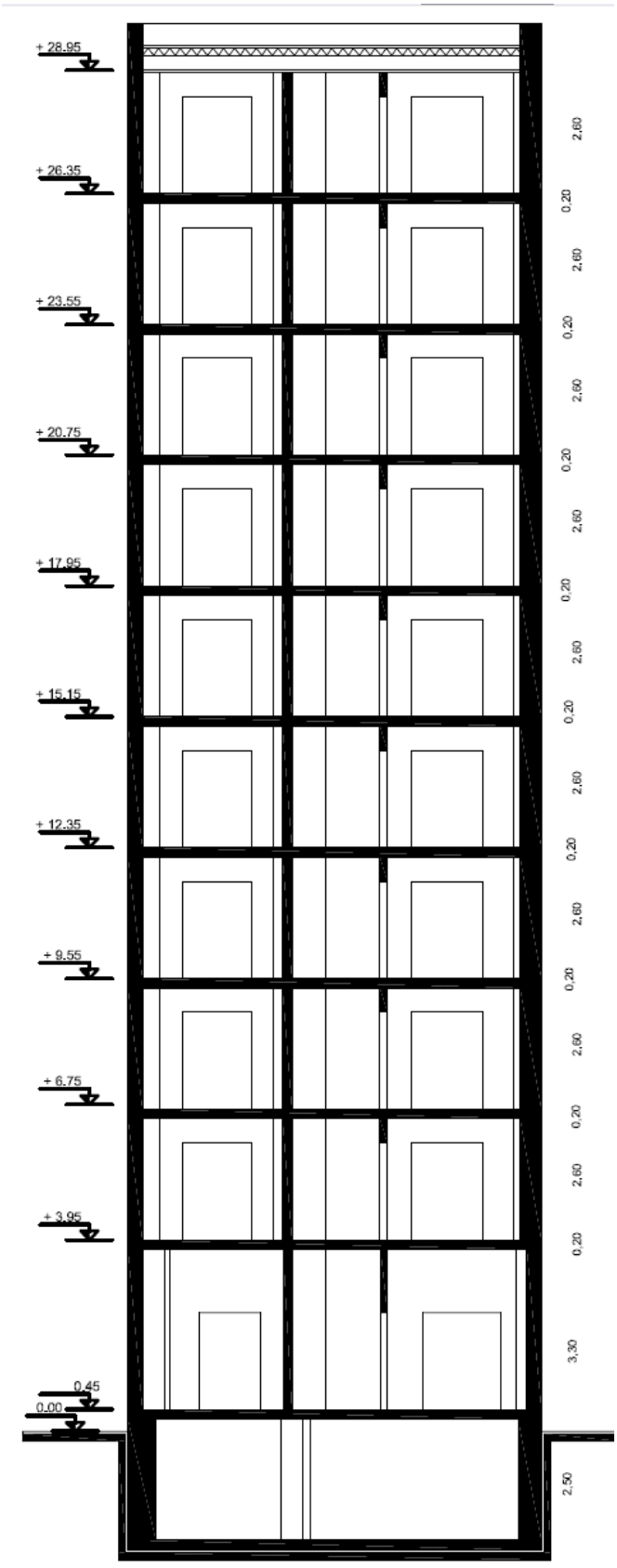


Figure 4. Facade and cross-sections with identification of heights relative to the floor, in the of Tucuman blueprints

The absolute 3D representation of buildings is not a common practice in Argentine cadastres. The 3D representation prototypes are generally generated in a GIS environment, showing the building as a function of the number of floors (the alphanumeric database indicates this value, which is multiplied by 3 meters to generate the real volume).

The official cadastral documents and survey blueprints are based on standards that are strictly limited to 2D representations on paper (although CAD applications are now popular, most of the professionals and institutions still conceive surveys blueprints as analog documents).

The laser scanning survey techniques are still not widespread in the country. Photogrammetric surveys are sporadic, but are nonetheless the most frequent way of generating altitude data and building heights. Most of the jurisdictions have not even published guidelines for 2D georeferenced surveys, much less 3D surveys.

3.4 Territorial Objects in the Context of a 3D Cadastre

The Cadastral National Law, No. 26.209, defines a new term: the "territorial object". In addition, it states that this object may be legal or not. Any portion of the territory that, by nature and means of access is finite and homogeneous, is a territorial object. A "legal territorial object" (*objeto territorial legal*, or OTL) is one that is generated by a legal cause. This legal cause may be a property title (as is the case in real estate transactions), an ordinance or law (as is the case in ownership restrictions, the creation of reservation areas, or the demarcation of an urban area), or even an international treaty (such as those that establish the borders between countries). The law stipulates that all the OTLs, and their public records, must be managed by the provincial cadastres.

Argentine law, through its Civil Code, recognizes the following OTLs:

• **Towpaths**: This is a restriction to private ownership established in Art. 2639 of the Civil Code, and is defined as a 35 meter strip measured from the shore of navigable waterways toward the interior of adjoining properties. No compensation can be claimed for this area, and it implies a hands-off or non-interference obligation.

• **Real Estate Right to a Forested Area**: Under National Law No. 25.509/2001, this is a real estate right. It is conveyed separately from land ownership, and allows somebody to plant in another parcel, but keep ownership of what was planted. In addition, it allows for the purchase of existing plantations in parcels that belong to others. This is a temporary right, with a maximum duration of 50 years, and can be canceled if it is not used for 3 or more years. This right is granted by contract and must be recorded in the Registry of Deeds.

• **Active Real Estate Easements**: Under Art. 2970 of the Civil Code, an active easement (*servidumbre*) is a real estate right, permanent or temporary, exercised over a property owned by others. It is a restriction to the right of ownership by the property titleholder. An easement requires two real estate properties, a master and a slave, which must belong to different owners.

• **Rights Granted under the Mining Code**: The Mining Code was established by Decree No. 456 of 1997. It regulates the property of mines, and the rights of exploration and operation. In Art. 7, it stipulates that the mines are private assets of the Federal Government or the Provinces, depending on their location. Art. 10 of the Mining Code stipulates that "independently of the original ownership by the State… the private property of the mines can be established by legal grant". This granting of mining rights can be interpreted as a mining easement to the mining company. On the other hand, Art. 12 defines the mines as real estate

properties. Art. 20 establishes a mining cadastre to describe the physical, legal, and other useful information about mining rights. Those rights are identified with points that represent the vertices of the "area" defined in the requests for exploration permits, discovery manifests, etc. However, the Mining Code does not mandate in any of its articles the volumetric representation of the mineral to be explored.

• **Restrictions under the Aeronautic Code**: The Aeronautic Code was established by National Law No. 17.285 of 1967, and it describes the limitations to ownership of property located close to airports. This Code defines the limits to obstacles in the airspace in airports and their surrounding environment, to ensure the secure landing and takeoff of aircrafts. Although these obstacles are by nature volumetric bodies, they are represented by their surface projections on land. However, cross-sections are also enclosed to describe the height over land over which the restriction extends.

• **Administrative Easements of Utility Pipes** (electrical conduits, gas pipes, etc.): Both the National Law No. 19.552 for electrical conduits, and the National Law No. 17.319 for hydrocarbons, stipulate that administrative easements fir ducts affect ownership by imposing restrictions and limitations needed to build, maintain, repair and use a pipe or duct that is an essential component of an energy system. These administrative easements are represented graphically as areas or surfaces, with no consideration for the height (electrical conduit) or depth (gas pipe) at which they are laid.

• **Urban Restrictions**: These types of restrictions are established by municipal ordinance and have the goal of fostering coexistence between neighbors, improving the general welfare and ensuring public health. Some of the salient features of urban restrictions are the obligation of noninterference and the lack of compensation for the affected property owner. Some examples are: Chamfered corners (for visibility), building setbacks, recess of common walls between buildings, land use regulations, street extensions, etc.

• **Restrictions to Protect Native Forests**: National Law No. 26.331 places restrictions on the use of native forests within a rural property, and defines three conservation categories:

- Category I (red): Areas of very high conservation value.
- Category II (yellow): Areas of medium conservation value.
- Category III (green): Areas of low conservation value.

• **Restrictions for the Protection of Glaciers**: The National Law No. 26.639 of 2008 places restrictions for the conservation of glaciers and the periglacial environment. Art. 3 creates a National Glacier Inventory, with useful information to protect, control and monitor glaciers. Art. 4 stipulates that the National Glacier Inventory shall contain information about each glacier and its periglacial environment classified by hydrologic watershed, location, area and morphology. The inventory must be updated at least every 5 years, and capture the changes in the glacier surface and its periglacial environment. This last article stipulates, among others, the obligation to measure the surface of the glacier and monitor it periodically to determine any changes in its size. This law does not make any volumetric references, even though it would be particularly interesting to study changes in glaciers over time.

4. CONCLUSIONS

The incipient initiatives to georeference cadastral parcels (even in 2D) and the territorial objects under the same system of reference represent the first step to establish a 3D cadastre in Argentina. Even though the provincial cadastres are still independent, their points of contact with the municipal cadastres will accelerate the process of creating territorial data in 3D.

The public and private utilities and the organizations that control the environment and air traffic must structure their data under the same system of reference as the territorial cadastres, representing their structures with equivalent precision.

Finally, in the context of a federal administration that scatters territorial data among the provinces, the strengthening of the Spatial Data Infrastructure of the Argentine Republic (*Infraestructura de Datos Espaciales de la República Argentina*, or IDERA) is the shortest path to the creation of 3D Multipurpose Cadastres in the country.

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