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Characterization of the Initial Variables of the LADM-COL Application Model for Cadastral Survey v 1.0



Dirección de
INVESTIGACIÓN
y prospectiva

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Land Administration Model – Colombia
Volume 6

**Characterization of the Initial Variables of
the LADM-COL Application Model for Ca-
dastral Survey v 1.0 (v.1)**



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Preliminary Considerations

The Instituto Geográfico Agustín Codazzi (Agustin Codazzi Geographic Institute –IGAC by its acronym in Spanish–), in its exercise as the maximum cadastral authority, gives the following linear and progressive documents, with the present one being the first. These documents are the result of a research process emphasized in bibliographical review and the generation of documents that could be used as input for the comprehension, development, and promotion of the Land Administration Domain Model (LADM) and the adoption of this one to the Colombian profile, denominated as LADM-COL.

Throughout the document review, it will be possible to encounter diverse technical and methodological analyses of the process, history, changes, and behavior that the LADM-COL Extended Model Cadastral-Registration, and the various application models that surged in the framework of Multipurpose Cadastre, thus seeking to make the cadastral approach the center of these writings so that the various actors of the cadastre and the community in general have within reach a purified and synthetic version of the processes, lessons and current state of the adoption of the models, based on official documentation from the IGAC as the governing body.

Regarding the documentation of these models, it has been observed that if the official information, issued by different national organizations, is contrasted over time, since the conception of the standard’s inclusion in Colombia, it may present some ambiguities or appear to be inconsistent in terms of the terminology associated with designated them and the competencies related to them. This corresponds to the institutional development, evolution, and understanding of the implementation of the Land Administration Model in Colombia, oriented towards cadastral management with a multipurpose emphasis.

In the ensuing part is a conceptual map displaying the name of each document, a brief description, and the position that it occupies within the sequence, to delimit its scope and provide the reader with a general overview that allows them to navigate its contents more easily (Figure 1).

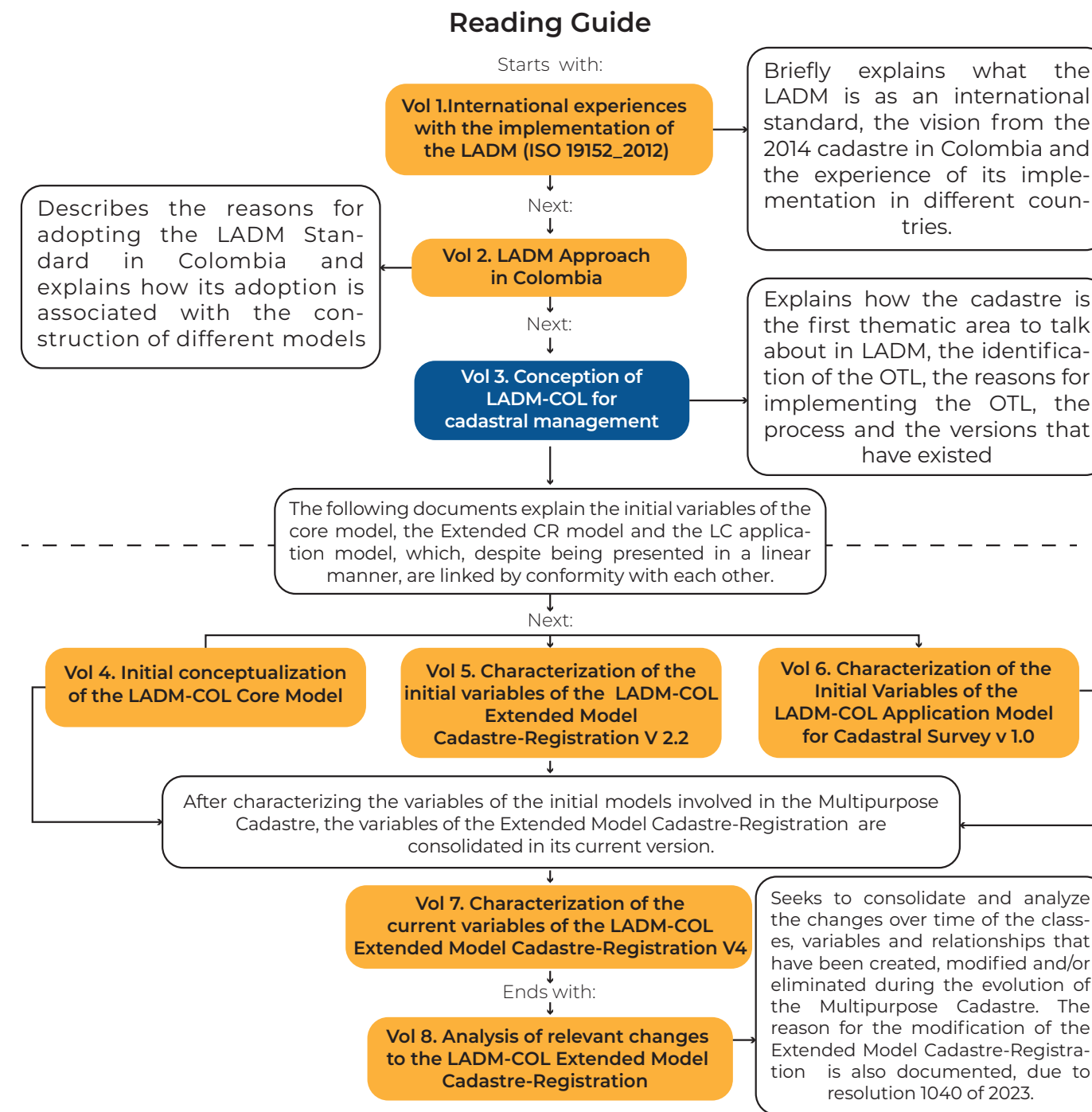


Figure 1. Reading Guide for Documents Related to LADM Conceptualization in Colombia.

Introduction

The Multipurpose Cadastre is implemented based on the LADM model according to the international standard ISO 19152:2012, which semantically and ontologically unifies the standards for land administration and, based on this, the LADM-COL Core Model is defined, which It is adopted through Joint Resolution IGAC 642-SNR 5731 of 2018, as a national profile, and in which an adaptation is made to the needs and reality of the Colombian territory, without altering its essence and from it the extended models will be built (thematic in nature according to the legal land object).

The extended models are based on the classes and relations of the core model and, depending on the legal land object (parts of the territory that share specific laws and homogeneous conditions), they can be specialized at will.

In order to meet the particular needs of the territory, application models are created, which define the semantics and minimum data structure for the characterization of the physical, legal, and economic components of the properties, through the processes of cadastral formation or updating with a multipurpose approach, such as the cadastral survey model.

Just as the extended models must be in conformity with the core model, the application models must be in conformity with the extended model from which they are derived. One of the main differences in the way in which the extended model specializes to become an application model lies in two (2) fundamental aspects:

- » The first is that an application model can be a *partial specialization*, that is, it can conceive subclasses from only a portion of the extended model without “citing” the classes of it that it does not specialize.
- » The second main difference comes from the competition to generate or propose an application model.

- » Therefore, the entity responsible for modifying, regulating, and documenting the LADM-COL Core Model is, exclusively, the Colombian Spatial Data Infrastructure (ICDE).

On the other hand, who is competent to modify, regulate, and document a certain extended model is the entity that governs the data of the basic administrative unit of the model in question, for example: The Agustín Codazzi Geographic Institute (IGAC by its acronym in Spanish) with the Superintendence of Notaries and Registry (SNR by its acronym in Spanish), govern the property information and therefore, have competence over the LADM-COL Extended Model Cadastre-Registration, ensuring conformity concerning the core model.

However, currently, the application models associated with cadastral management can be built by those entities that have power over the cadastre (*cadastral managers*), according to their needs, without prejudice to the fact that there is diversity in the application models among the different managers, without losing sight of the fact that there are some of these application models that are binding for the managers, such as the Cadastral Information Report (RIC) Application Model.

For that reason, interoperability and the ability to generate uniqueness in the information lie in the fact that the application models are built at the discretion of the managers and are in conformance with the extended cadastre-registration model since they are specific to each extended model and respond to specific needs.

Considering the aforementioned, the IGAC, as cadastral manager, built the Cadastral Survey Application Model, which can be consulted through the entity’s website and can be adopted by other managers who require it or can be used as a guide since it is not binding or mandatory in its use.

The Cadastral Survey Application Model built by the IGAC became mandatory at the time of the publication of Resolution 1149 of 2021, through which the regu-

latory adjustments of scope and approach were made, as stated above, to exploit the flexibility of the LADM-COL standard in the service of the diversity present in the Colombian territory, respecting the autonomy enjoyed by cadastral managers.

The cadastral survey application model (from now on MALC by its acronym in Spanish) has three (3) versions (1.0, 1.2, and the current 2.0). This document characterizes the initial variables of the application model and describes the elements of version 1.0. It is important to consider that its construction was based on the extended model cadastre-registration in its version 3.2 and core 3.0, therefore, throughout the document, it will only reference these models, however, there will be some emphasis in some sections.

Additionally, the process carried out for its creation will be mentioned, starting from the UML modeling process and its respective layout and construction. This will allow whoever uses this characterization instruction to identify the structure of the classes shown here and the respective color codes.

About UML Modeling

UML or Unified Modeling Language, is a standardized language that is used to visualize different elements (classes) and the relationships among them in software systems and processes. With this language, the structure of the information is represented, as a “format” that the data must follow to keep the consistency of the data.

In this language, diagrams are constructed where rectangular shapes represent specific objects called classes. As an example, as illustrated in Figure 2, there is a box with the name Predio at the top. The whole box represents a class, as an object that can be characterized by means of attributes, i.e., characteristics of it that are stored as data and that appear as a list inside the box. Thus, an object of the class Predio is described by Departamento, Municipalidad, Zona, NUPRE, (Land Property Identification Number), (...).

Each attribute has a name, the one that appears in the list, with a definition that is recorded in a data dictionary. It also has a cardinality, that is, the diagram also defines whether the characteristic may or may not have multiple values (in the way that a person can have several siblings or not), and whether it is mandatory or not to register it.

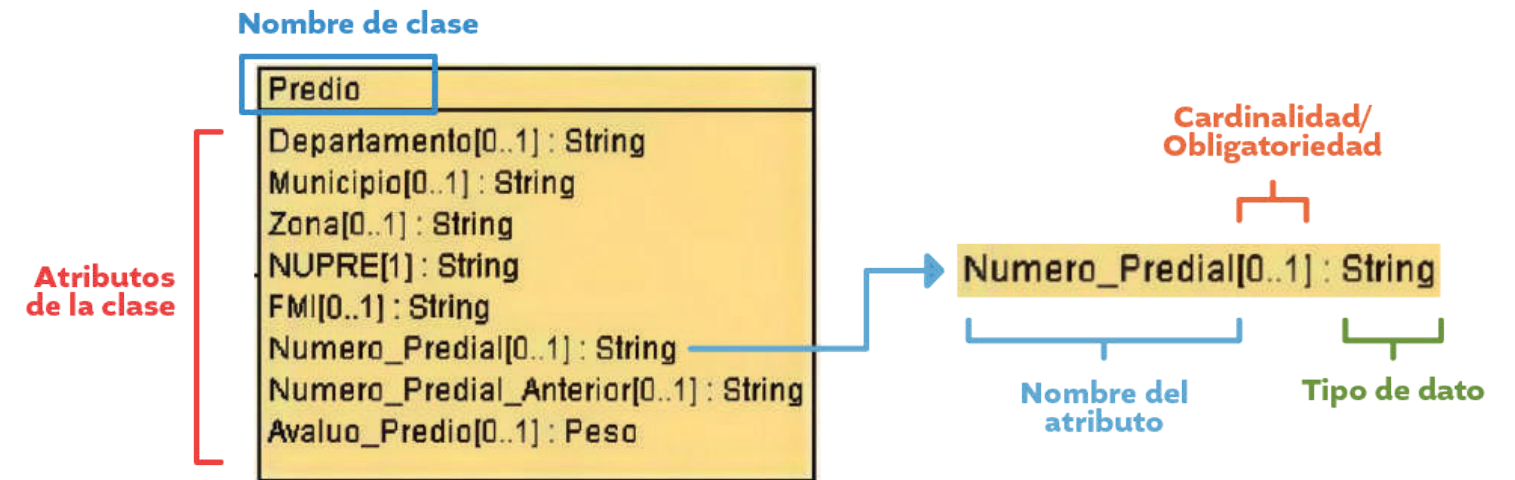


Figure 2. Classes and Attributes in UML. **Source:** IGAC (2023).

In the diagram, it is found that the classes are connected through the lines. Such lines represent the relationships that they have with each other, for example: Every construction belongs to a property and consequently, it must be possible to know which one belongs to each one.

These relationships are direct if the classes are directly connected by a line, however, there may be indirect relationships between them, as when two classes are connected by “transiting” through other classes in the middle of the relationship. Such relationships, like attributes, also have cardinality and obligatoriness.

The details on data types, obligatoriness, cardinality¹, and types of relationships are beyond the scope of this text, however, it is possible to delve into the various documentation on the UML language and/or on database design.

To characterize the initial variables of the application model, the characterization of the cadastral survey application model in version 1.0 will be used as a reference, which is built based on the extended model cadastre-registration in version 3.2, and the core model version 3.2. This document will focus on identifying its different parts in a general way and pointing out the differences concerning current practices and conventions in the construction of these models.

Generalities of the MALC

Structure of the MALC.

Figure 3 corresponds to the MALC UML diagram. It starts from the core model in version 3.1 (delimited with black), which specializes in the extended model cadastre-registration in version 3.2 (delimited in red) that also connects with the new (different, additional) classes that give rise to the MALC (see Appendix 4).

¹ A common misinterpretation of the concept of obligatoriness, specifically in the MECR, is that those who have responsibility over cadastral information have considered in some cases that if a piece of information “is not obligatory” it means that it is at their discretion to record it or not.

This is wrong since, when a relationship or attribute “is not mandatory”, what is being represented is that there are clearly defined cases in the legislation or in the cadastral regulations in which it is NOT correct to associate such information. For example: The informal property DOES NOT have a real estate registration folio (FMI by its acronym in Spanish) due to its nature, therefore, for this particular case, it should NOT be registered.

In general, the non-mandatory nature of a data or relationship responds to the diversity of cases that appear in the cadastre, and not to the discretion of the person who registers the information or to the difficulties that may arise in obtaining the data.

The above is an element for understanding the MALC, and to keep in mind in the construction of application models, in a general way, from the autonomy of the competent entities.

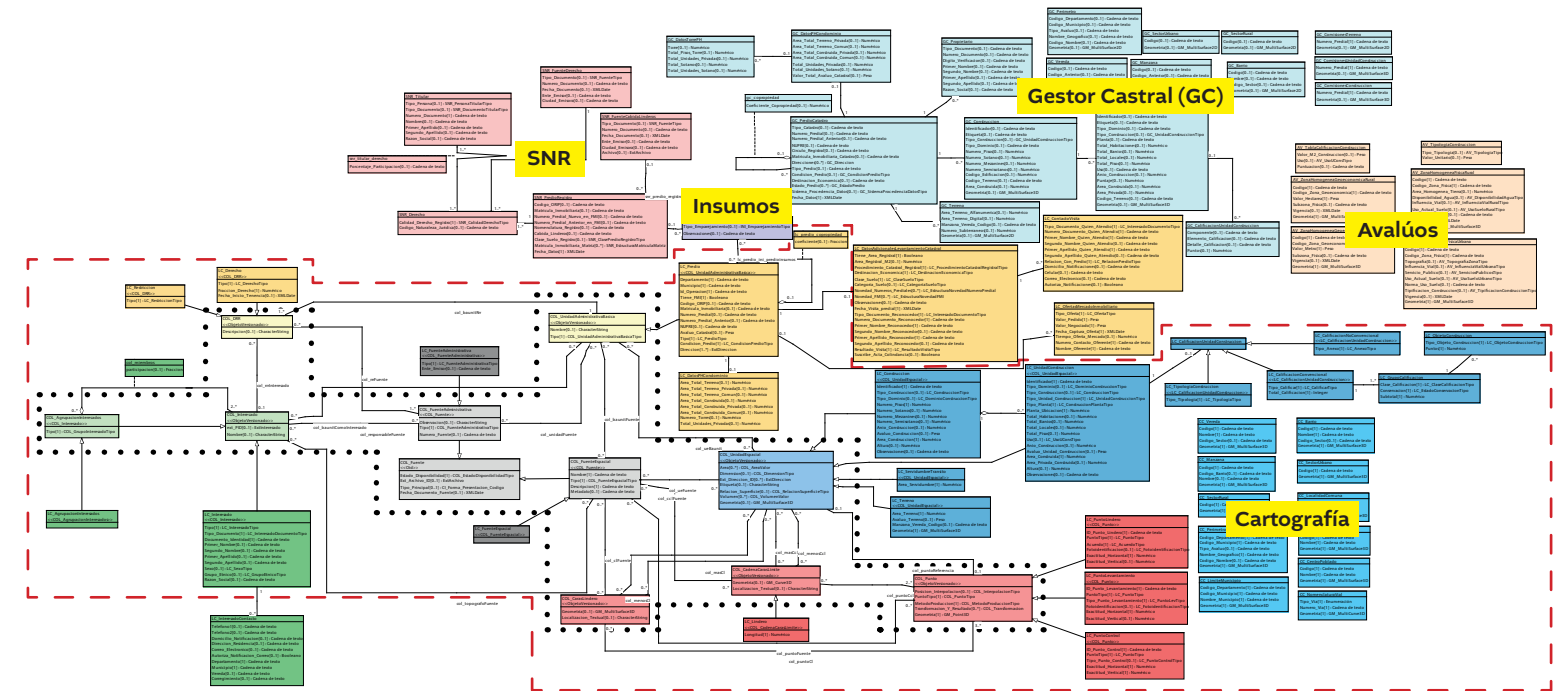


Figure 3. Identification of Common Elements Between the Core Model, Cadastre Registration, and Cadastral Survey. **Source:** IGAC (2022).

Considering that an application model is a total or partial specialization of an extended model, in this illustration the classes that omit some derivations have been highlighted with the symbol (?) in yellow and red. These are:

- » In yellow, COL_DRR omits the classes CR_DRR, CR_Responsibilidad, CR_Informalidad, and CR_Hipoteca, constituent classes of the Extended Model Cadastre Registry (version 3.0).
- » In gray, of the highlighted class (LC_FuenteAdministrativa) the class CR_AnotacionRegistro is omitted.
- » In blue, the class COL_Unidad_Espacial, omits its derivations associated with the Grouping of Units, one of them is from the core model (version 3.0).
- » It is not highlighted, but the class CR_Publicidad has been omitted.

Finally, to clarify before the multiple subsequent versioning, throughout the reading of this document, in which a description of its parts will be made, two elements about this core model should be taken into account:

1. The core model presents slight variations to the current one (version 3.2), specifically that the class of the COL_CarasLindero Surveying and Representation Subpackage (Red) currently does not exist.
2. As will be expressed in the following paragraphs, the MALC does not present the color or notation conventions that have already been adopted.

Color Convention.

In general terms, Figure 3 shows the color convention of the core model as follows:

- » Yellow represents the Administrative Package, where the basic administrative unit is located, the class where rights, restrictions, and responsibilities are present and from which other related classes are derived.
- » In green is the Party Package, which involves those who have the rights, restrictions, and responsibilities over the properties, as the legal land object of the extended model cadastre-registration.
- » In gray is the Document Package, whose classes are created to deposit the documents that support the other information, such as orthophotographs, and deeds, among others, based on the fact that the cadastre is a registry objective based on evidence and technical criteria.
- » In blue (center) is the Spatial Unit Package, in which the elements of the basic administrative units are associated.
- » In blue (lower right side), there is the cartography submodel.

- » In red, is the Surveying and Representation Subpackage, which groups the classes themselves in which the geographic objects themselves are represented that allow the location or spatial identification of the basic administrative units.
- » In light orange (upper right side) is the Land Valuation Submodel, with the respective classes that serve to characterize the information of the physical and geoeconomic homogeneous zones.

The cadastral survey model version 1.0 consists of the main structure and input submodels. These submodels are shown in the upper part of Figure 3:

- » In pink (upper left side) are the inputs provided by the Superintendence of Notaries and Registry.
- » In blue (upper right side) is the Cadastral Manager Submodel (CM), which corresponds to the inputs needed to start the survey process.

Currently, a convention has been adopted in which the colors mentioned in the packages and subpackages are respected, in addition, different shades of these are handled: the lighter shades are reserved for the core model classes, intermediate for the extended model, and darker for the application model. In the case of the model discussed in this document, only the core model is differentiated with a lighter shade, and different colors are used to define the classes of the application model (differentiated from the extended model), as will be developed later on.

Class Naming Convention.

Currently, the use of the prefixes in the class names is defined, as showed below:

- » All classes of the core model must begin with the prefix COL_, it applies to MALC version 1.0.
- » All classes of the Extended Model Cadastre-Registration must begin with the prefix CR_.
- » The classes of the application model are derived from or directly connected to the classes of the extended model, they will carry the prefix LC_ (Levantamiento Catastral- cadastral survey in Spanish) in this case.
- » In case a class is modified (by adding or removing an attribute, for example), its name must be prefixed with the name of the model that modifies it. For example: a class of the extended land registry model that is modified in the MALC by including other attributes, should carry the prefix LC_, instead of CR_.
- » There may be different prefixes corresponding to a particular submodel. For example, in pink, in the upper part of Figure 3, the submodel with the prefix SNR_ could be seen, which refers to the information under the jurisdiction of the Superintendence of Notaries and Registry).

Among these are the mapping submodel (CC_), of the extended model (on the right side), and the submodels SNR (SNR_), cadastral manager (GC_), and land valuations (AV_), in the upper part, specific to the MALC, which are connected to the extended model through the INI_PredioInsumo class.

In MALC version 1.0, the classes of the core model retain the prefix COL_, however, all classes of the extended model were prefixed with LC_ even when they had not been modified².

² As indicated by the considerations at the beginning of this series of documents, this does not correspond to an error, since chronologically the construction of version 1.0 and its subsequent manipulation was part of the process that led to the adoption of the current conventions, already included in version 2.0 of the MALC.

In this document, however, the classes whose attributes have changed are highlighted with the sign (?) in shades of green:

- » On the left the object LC_Derecho included the attribute Fecha_Inicio_Tenencia.
- » On the right, the MALC class LC_Predio omits several attributes of the class CR_Predio, some of which are contained in the class LC_DatosAdicionales-LevantamientoCatastral, while two are simply omitted (Tiene_FMI and Avaluo_Catastral).

MALC Version 1.0 Variables

In order to observe the variables that form the MALC, a package-by-package verification of the model will be carried out below.

Administrative Package

For the administrative package, there is the core model class LA_RRR (observations have already been made on this nomenclature) and the basic administrative unit, which will be observed separately.

Basic Administrative Unit.

As mentioned in the introduction, the core model allows its complementation in different elements of land administration and revolves around the basic administrative unit, which in the case of cadastre-registration is the property, therefore, the class LA_BAUnit is also abstract, it is instanced through the class Predio (Property in English), which is the land object. This is described mainly by

the elements that identify the property as such: número predial, folio de matrícula inmobiliaria, the Id_Operacion, which is the temporary unique identifier of each property that is assigned in the development of the cadastral survey, among others; the only attribute that does not fulfill this function is Avaluo_Catastral, where the value of the property is defined (Figure 4).

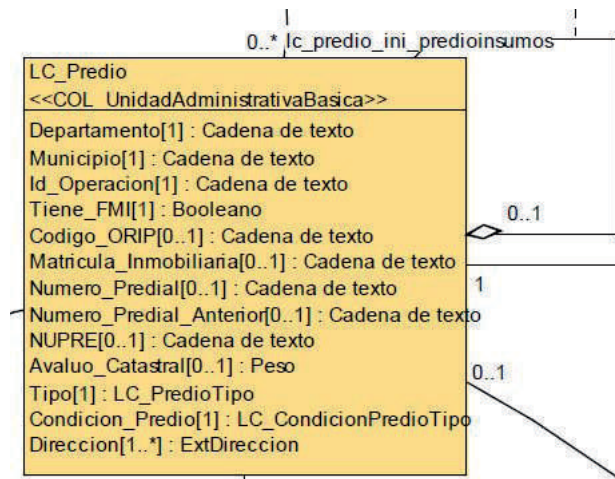


Figura 4. Basic Administrative Unit: LC_Predio. MALC Version 1.0. **Source:** IGAC (2021).

Rights, Restrictions and Responsibilities

The relationship between parties and the basic administrative unit is through restrictions, rights, and/or responsibilities (class). For example, a party has rights over a property if he/she is its owner, backed by a public deed defining him/her as such.

Responsibilities refer to the legal or administrative obligations related to the land, rights represent the legal entitlements of the parties to the land, and restrictions are the obligations that fall on those who have rights to the land.

The COL_DRR class is abstract. This means it is only instanced through the inherited classes, which, in the case of MALC, are LC_Derecho and LC_Restriccion. This means that no data is LA_RRR only, without being a restriction, a right, or a responsibility (Figure 5).

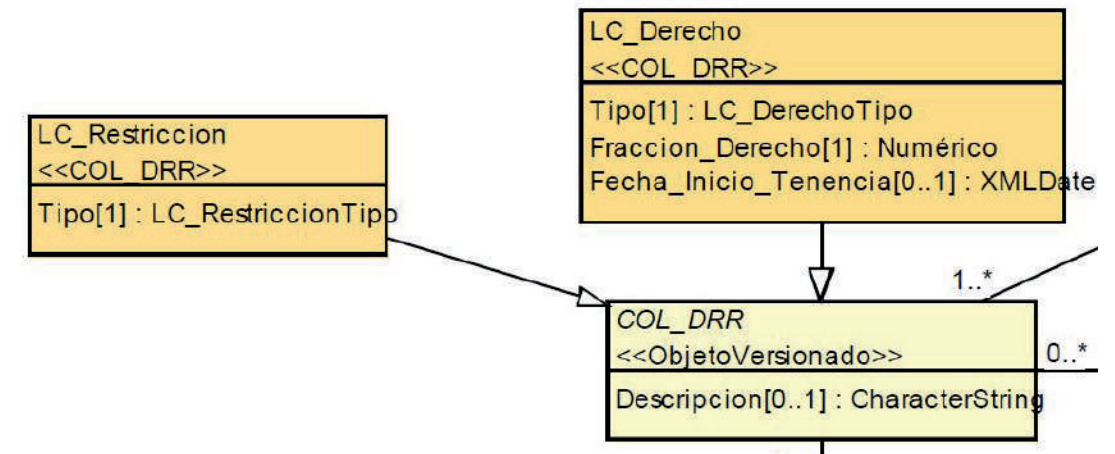


Figure 5. Restrictions, Rights, and Responsibilities of the Administrative Package in MALC Version 1.0. **Source:** IGAC (2021).

The above implies that the inherited classes inherit the attributes of the parent class. For example, LC_Derecho would have 1 inherited attribute as described in Table 1.

LC_Derecho	
Tipo[1]: LC_DerechoTipo	Own class
Fraccion_Derecho	
Fecha_Inicio_Tenenci [0..1]XMLDate	
Descripcion[0..1]:CharacterString	Inherited from the parent class

At the bottom of the model (with the same color convention) are the attribute domains of these classes. When the data type of an attribute is a domain, it means that it can only take one value from a fixed list of values. For example, LC_Derecho has the attribute LC_DerechoTipo. By observing this domain, it can be identified that the types of law are those that are highlighted in Figure 6: Dominio, Ocupación y Posesión (Domain, occupation, and possession in English).

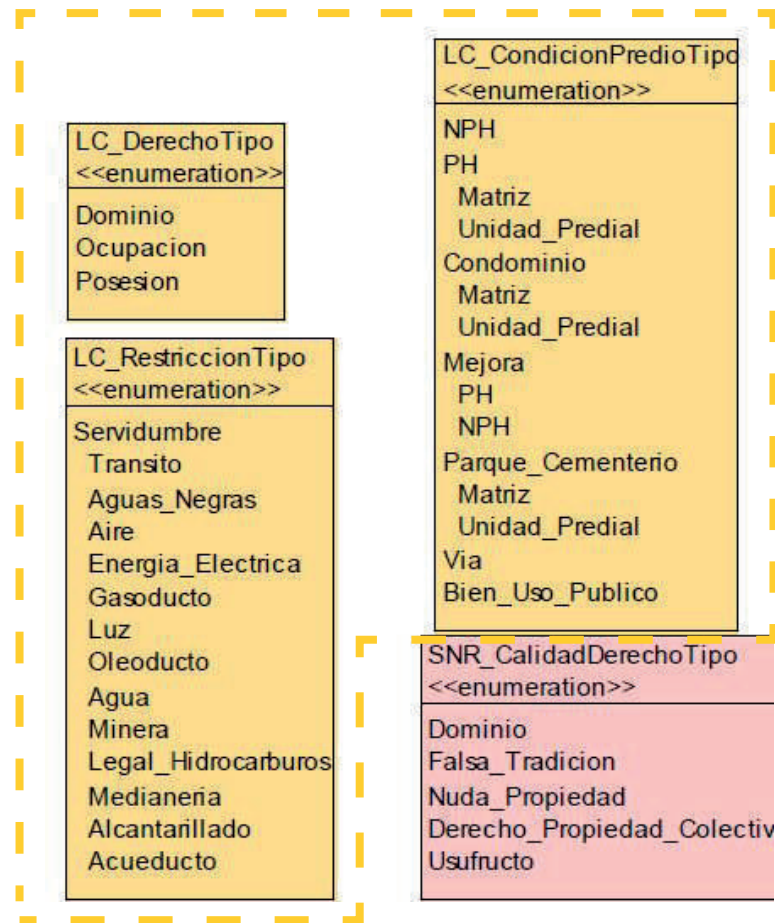


Figure 6. Domains of the Administrative Package in the MALC Version 1.0.

Source: IGAC (2021).

Party Package

The Party package is made up of two classes that belong to the core model (COL_Interesado and COL_Agrupacion_Interesados). These two classes are abstract, meaning they are only instanced through their inherited classes. In this case, a party can only be a natural person or a legal entity.

In the same way, there is the class LC_Agrupacion_Interesados as well. derived from LA_Interesado, which allows constituting in the structure of data a group of legal and/or natural persons, giving rise to the class members, where the percentage of participation can be recorded, in case of not being equal within the group.

Additionally, the application model has the class LC_Interesado, in which the type of party and their respective identification are related. The LC_interesadoContacto class is related to this, which seeks to obtain base information such as contact number or address of the party (Figure 7).

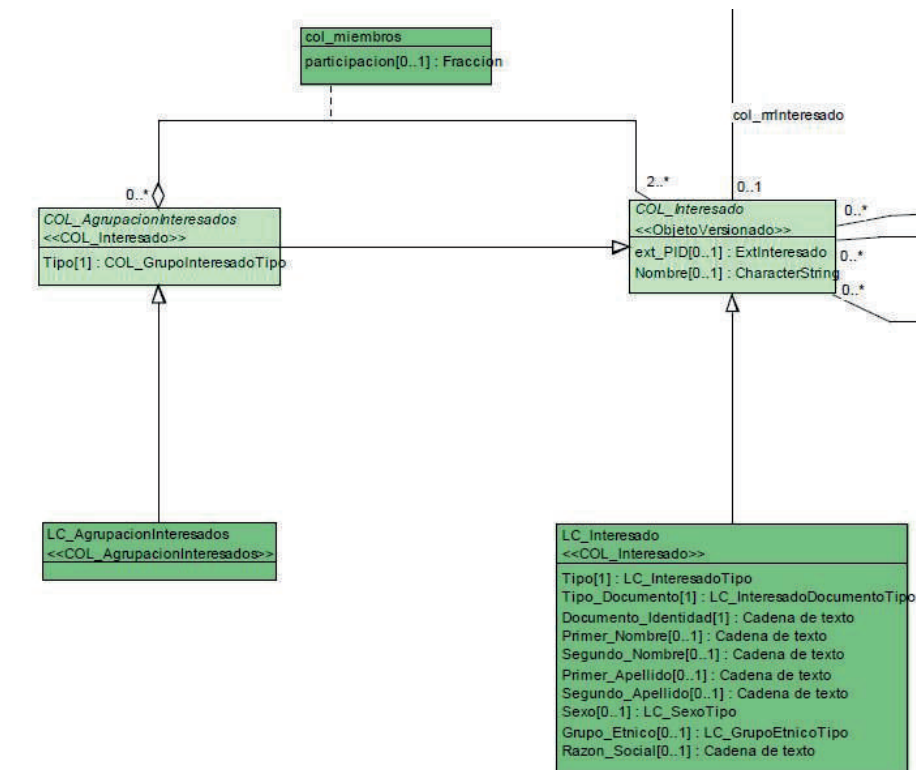


Figure 7. Party Package in MALC Version 1.0. **Source:** IGAC (2021).

Likewise, the Party Package has domain type attributes (Figure 8).

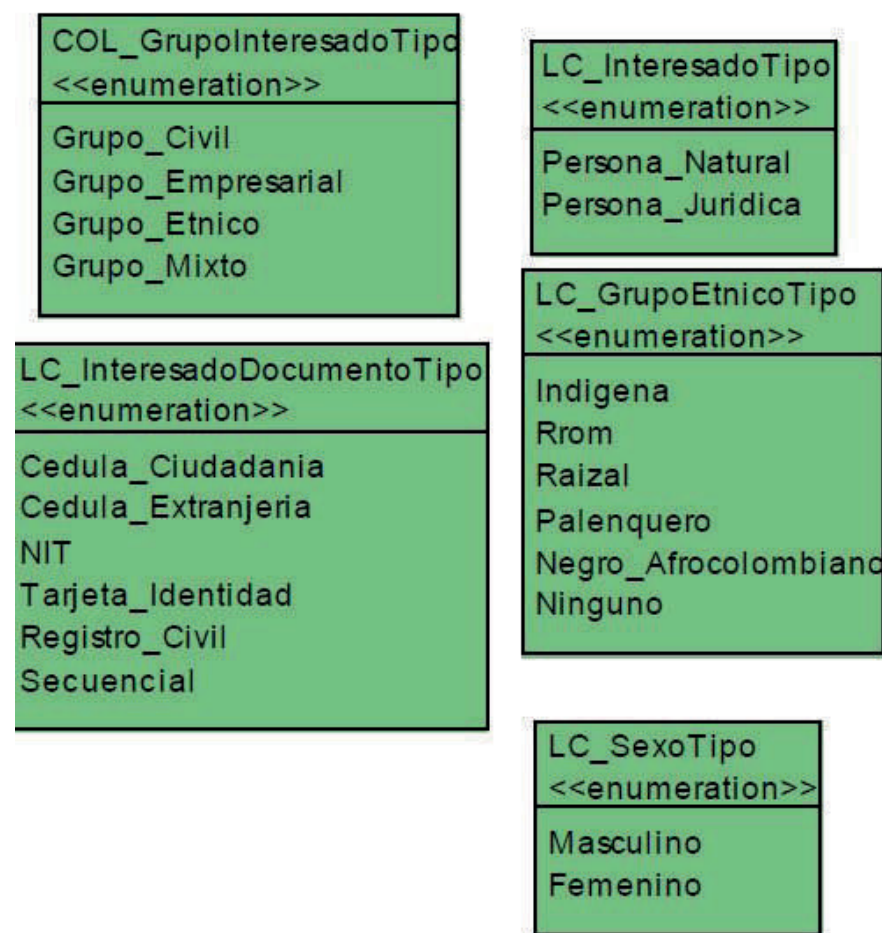


Figure 8. Domains of the MALC Party Package Version 1.0. **Source:** IGAC (2021).

Naturally, as it is derived from the extended model, it preserves the semantic relationship of the Party Package, which characterizes the natural persons, legal entities, or groups of those that have rights, restrictions, or responsibilities over the properties, just as in the extended model.

Document package

The document package (Figure 9) is made up mostly of classes that belong to the core model, however, in the MALC two classes related to its application are added.

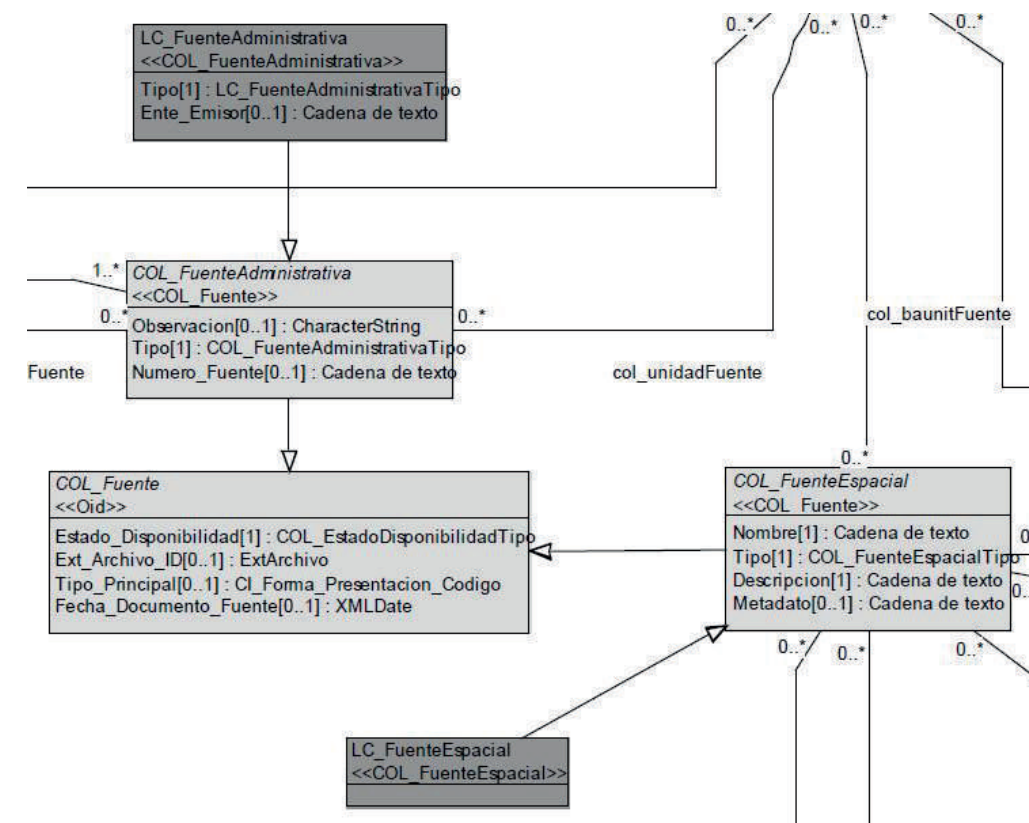


Figure 9. MALC Document Package Version 1.0. **Source:** IGAC (2021).

The document package is built around the parent class COL_Fuente, which is also abstract and specializes in spatial sources (COL_FuenteEspacial) and administrative sources (COL_FuenteAdministrativa).

Since the register of cadastral information is based on objective technical criteria it is essential to document the evidence or information source to validate that the entries in the databases are not arbitrary. For example, a protocolized plan of a public deed that allows the dimensions of the parcel associated with a property to be verified, or in general, any source of information, such as notarial documents, maps, and plans, among others, that comply with said function.

The class LC_Fuente_Administrativa inherits the attributes of COL_Fuente_Administrativa and has its own attributes such as the Type and the Issuing Entity. On the other hand, the LC_Fuente_Espacial class inherits the attributes of the class COL_Fuente_Espacial, without having additional attributes. In Figure 10 the domains associated with the classes of the document package are found.

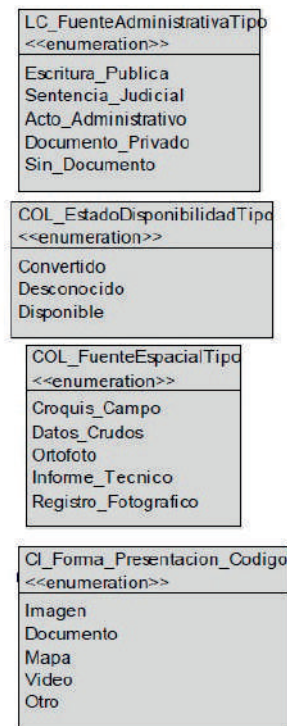


Figure 10. Domains of the MALC Document Package Version 1.0. **Source:** IGAC (2021).

Spatial Unit Package

In the MALC, the spatial package (Figure 11) consists of classes that store spatial information inherent to the property. It is based on the class COL_UnidadEspacial which, like others mentioned, is abstract and consequently, is instanced through its derivate or inherited, in which the geographic, characteristics such as Terrenos, Construcciones, Unidades de construcción, and Servidumbres are deposited.

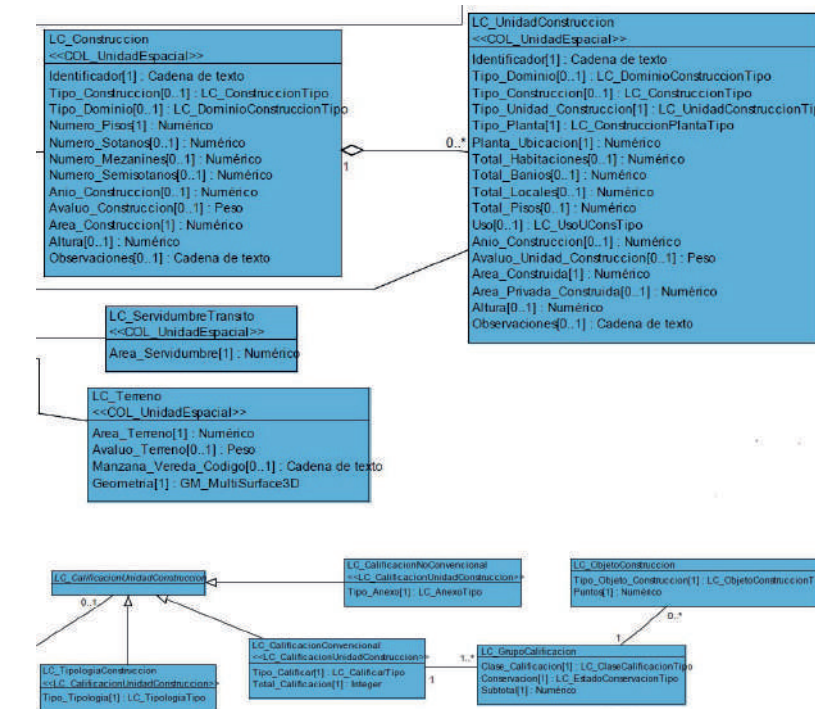


Figure 11. MALC Spatial Unit Package Version 1.0. **Source:** IGAC (2021).

LC_Construccion, LC_UnidaddeConstruccion, LC_Terreno, and LC_ServidumbredeTranito have their own class. While LC_TipologiaConstruccion, LC_CalificacionConvencional, and LC_CalificacionNoConvencional start from the abstract class LC_CalificacionUnidadConstruccion.

On the other hand, two additional classes allow variables to be identified regarding construction: LC_ObjetoConstruccion, and LC_GrupoCalificacion.

It should be noted that the geographic representation itself (points, lines, polygons, based on coordinates), as well as the characteristics of the geographic objects, are deposited in the Surveying and Representation Subpackage, and not directly in the Spatial Unit Package. Although, naturally, they are related one to one. Details on this Subpackage will be presented later.

The Cartography Submodel is also available, which can be considered as a resource that provides additional information on the sidewalk, neighborhood, locality, or commune in which the property is located (Figure 12). Although it is not directly linked to the main structure and the spatial package, it has a significant relationship.

In essence, it can be seen in the UML diagram of the model that this is a “branch” that is not altered by the modifications that lead the MECR to become an application model. Therefore, it retains the different classes, where each one represents an independent spatial object and consequently, in each class, the attributes of these objects are recorded. For example, although the buildings are located on the land, they are different objects, since on the same land there may be several or no buildings and, at the same time, the buildings have their own characteristics that the land does not have, such as the number of floors, which is why this attribute is found in the UnidadConstruccion and not in Terreno class.

The difference in this package, concerning the MECR, lies in the domains of its attributes, such as the typification of the different characteristics of each class, as shown below (Figure 13).

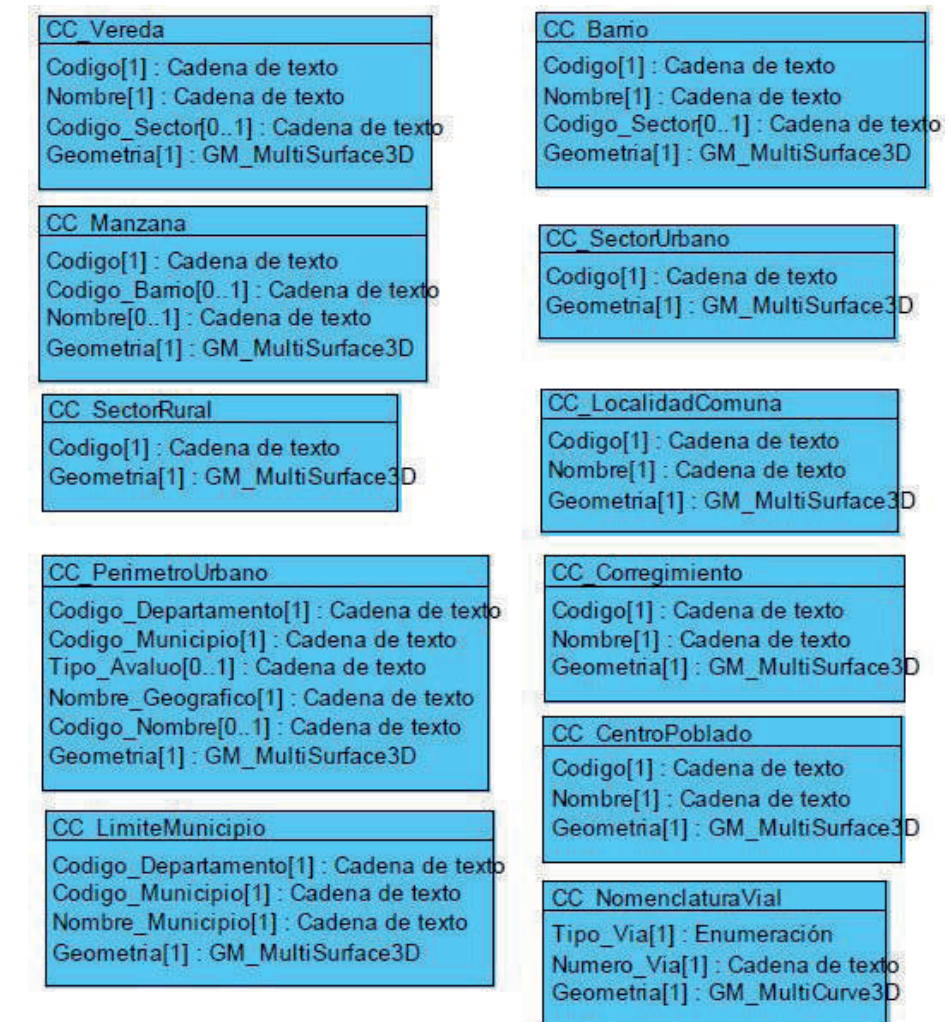


Figure 12. Spatial Unit Package (Cartography Submodel) MALC Version 1.0.

Source: IGAC (2021)



Figure 13. Domains of the MALC Spatial Unit Package Version 1.0.

Source: IGAC (2021)

Surveying and Representation Subpackage.

As noted in the description of the Spatial Unit Package, this Subpackage is derived from it and contains the representation of the associated geographic objects (Figure 14). It retains the three classes of the core model, LADM-COL: COL_CarasLindero, COL_CadenaCarasLimite, and COL_Punto.

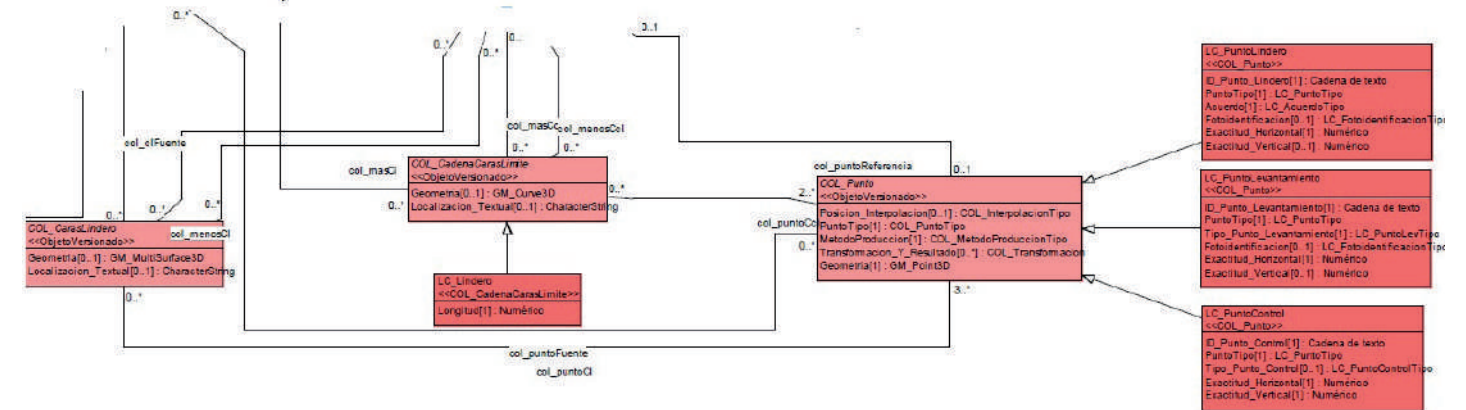


Figura 14. Surveying and Representation Subpackage in MALC Version 1.0.

Source: IGAC (2021)

COL_CadenaCarasLimite, and COL_CarasLindero allow storing the representation of the border (lines that form it), whereas the difference lies in that COL_CarasLindero allows a three-dimensional representation.

COL_Punto, constitutes the minimum unit of representation, taking into account that every figure is derived directly or indirectly from this one. For example, polygons are derived from the lines that limit them, and likewise, lines are derived from the points they connect. COL_Punto is an abstract class from which three inherited classes are derived: LC_PuntoLindero, which refers to the points that make up the borders (land), LC_PuntoLevantamiento, associated with the vertices of constructions or easements and LC_PuntoControl, associated with the points that make up or are tied to the geodetic network and that serve as a reference to control the precise location of the above (Figure 15).

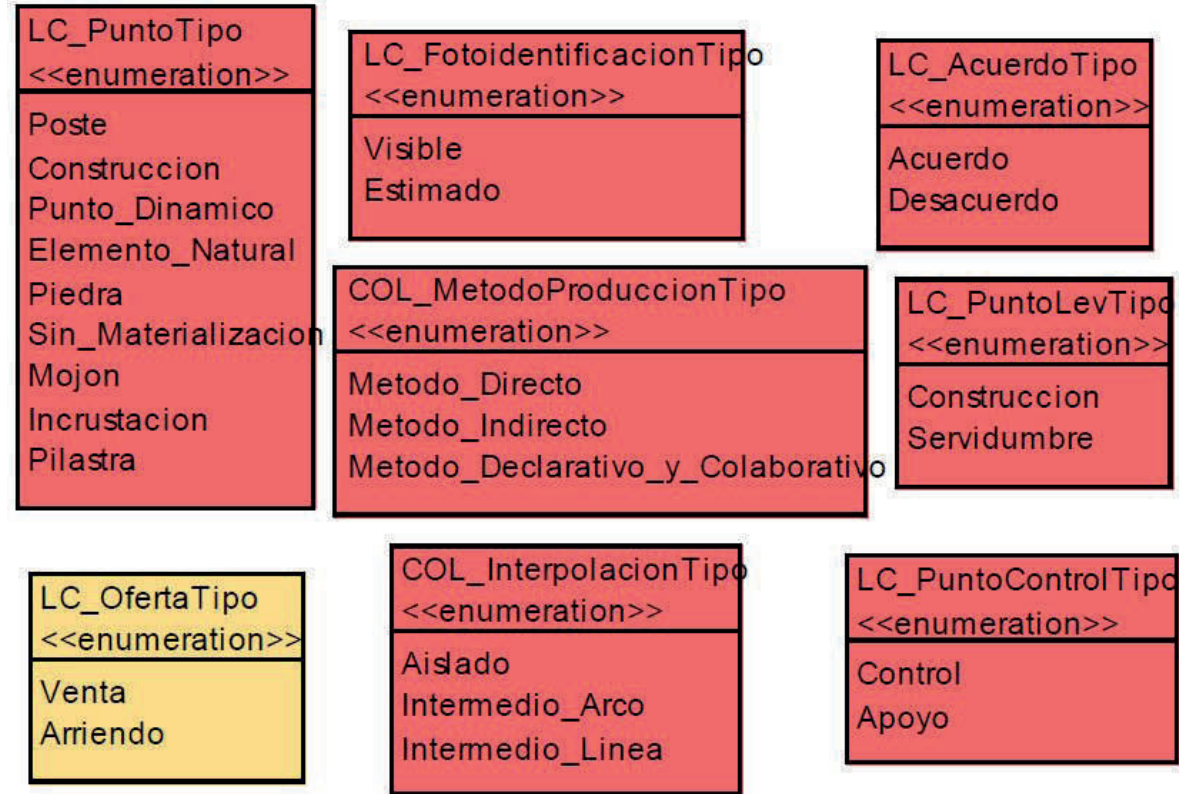


Figure 15. Domains of the Surveying and Representation Subpackage in MALC Version 1.0.

Source: IGAC (2021)

In summary, the Surveying and Representation Subpackage contains the representation of the geographic objects (coordinates) and the information that allows both to identify them correctly and to technically characterize how they were obtained. For example, what vertical or horizontal precision they have, if they were obtained from a neighbor’s agreement, or if they are from milestone points, among other information. These are the objects that give the exact reason for the location of the geographic elements of the model.

Information Input Submodels

Version 1.0 of the cadastral survey application model consists of a main structure that has been previously detailed in the aforementioned packages. At the top, there are the internal submodels, which cover both the information from the Superintendency of Notaries and Registry (SNR) and the Information Input Submodel of the Cadastral Manager. Currently, the Cadastral Manager’s Input Submodel is summarized in the cadastral information transfer application model regulated in Resolution 1040 of August 8, 2023.

SNR Information Input Submodel.

This submodel is internal and the SNR is in charge of its implementation, its main function is to provide the necessary legal information that will serve as input in the cadastral survey process. It can be noted that its classes have their own color, and have the prefix SNR_ (Figure 16).

When detailing the content, the presence of apparently redundant information among the SNR Information Input submodel is evident. For example, in the class SNR_Titular there is the attribute Tipo_Persona, which is already typified in the Party Package, as described in the respective section.

This responds to the competencies on the information, and the objectives of its presence in the model. Accordingly, the objective of the MECR, as an information outline, is to provide the field to record it, while that of MALC includes the submodel for the specific process of acquiring, recording, and maintaining such information.

Understanding that the SNR has the governance of the data on the register of the property and tenure of the owners of the real estate, it is its competence to register, safeguard, and attest to the veracity of such information, which is why it constitutes an input in the MALC.

Land valuation Submodel.

The Land Valuation Submodel (Figure 18) is designed to provide a record of information on the economic component as a result of cadastral updating processes, in cases where homogeneous physical and geo-economic zones have been adopted for the determination of values. The classes of this Subpackage have the prefix AV_.

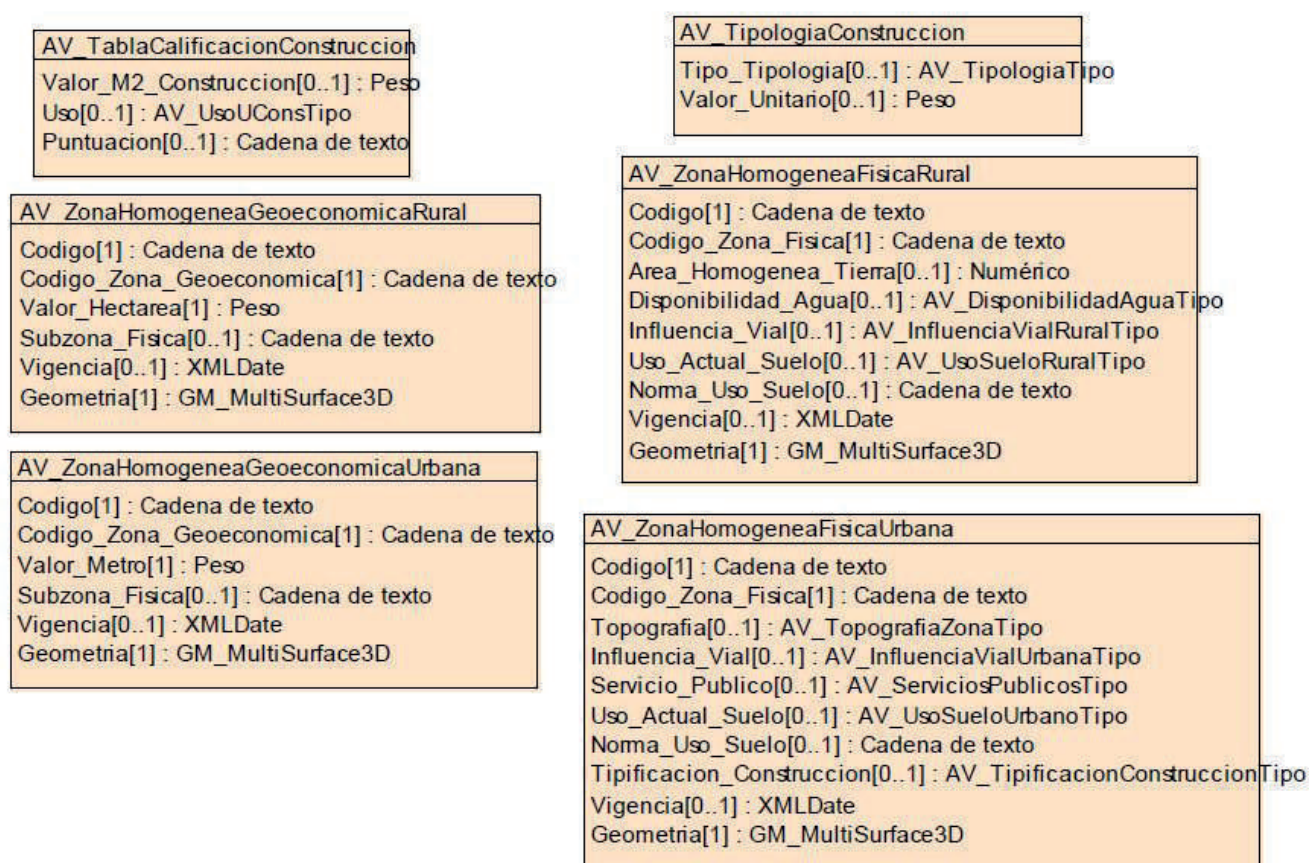
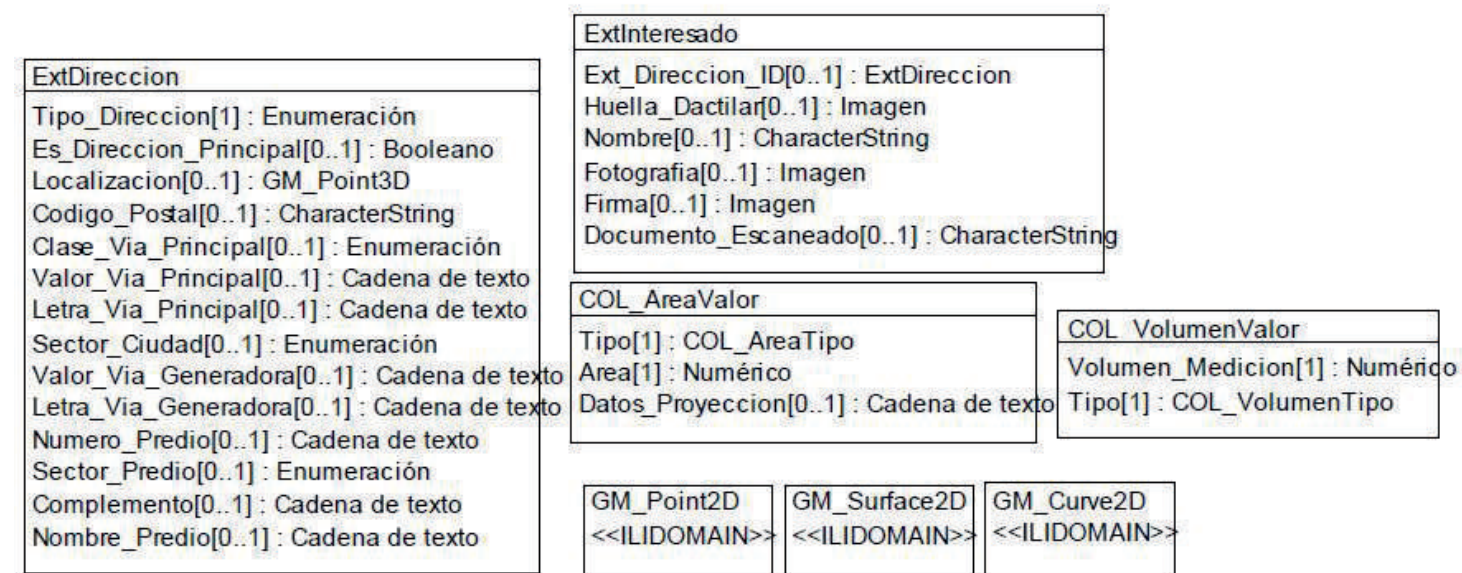


Figure 18. MALC Version 1.0 Valuation Submodel.

Source: IGAC (2021)

Tables of Structures

Finally, there are some attributes in the different classes of the packages whose data type is not a number, a string, or a domain, but an aggregation of different data types that, despite being more than one, constitute a unit and have a structure (the name they receive). These are shown in Figure 19.



Conclusions

The description of the model was presented, it was organized by packages, and its various classes were presented, in a consistent manner with the development of the higher hierarchy models. The main differences can be seen in the inclusion of the different submodels in the upper part of the diagram that incorporates the MECR classes where SNR inputs are related and the cadastral managers as actors of the survey or supply of information of the model, and the land valuation model.

In addition, despite the name cadastral survey, the *raison d'être* of the incorporated submodels simultaneously responds to multiple purposes.

For a more detailed definition of each MALC attribute or class, please consult the data dictionary of the institutional repository.

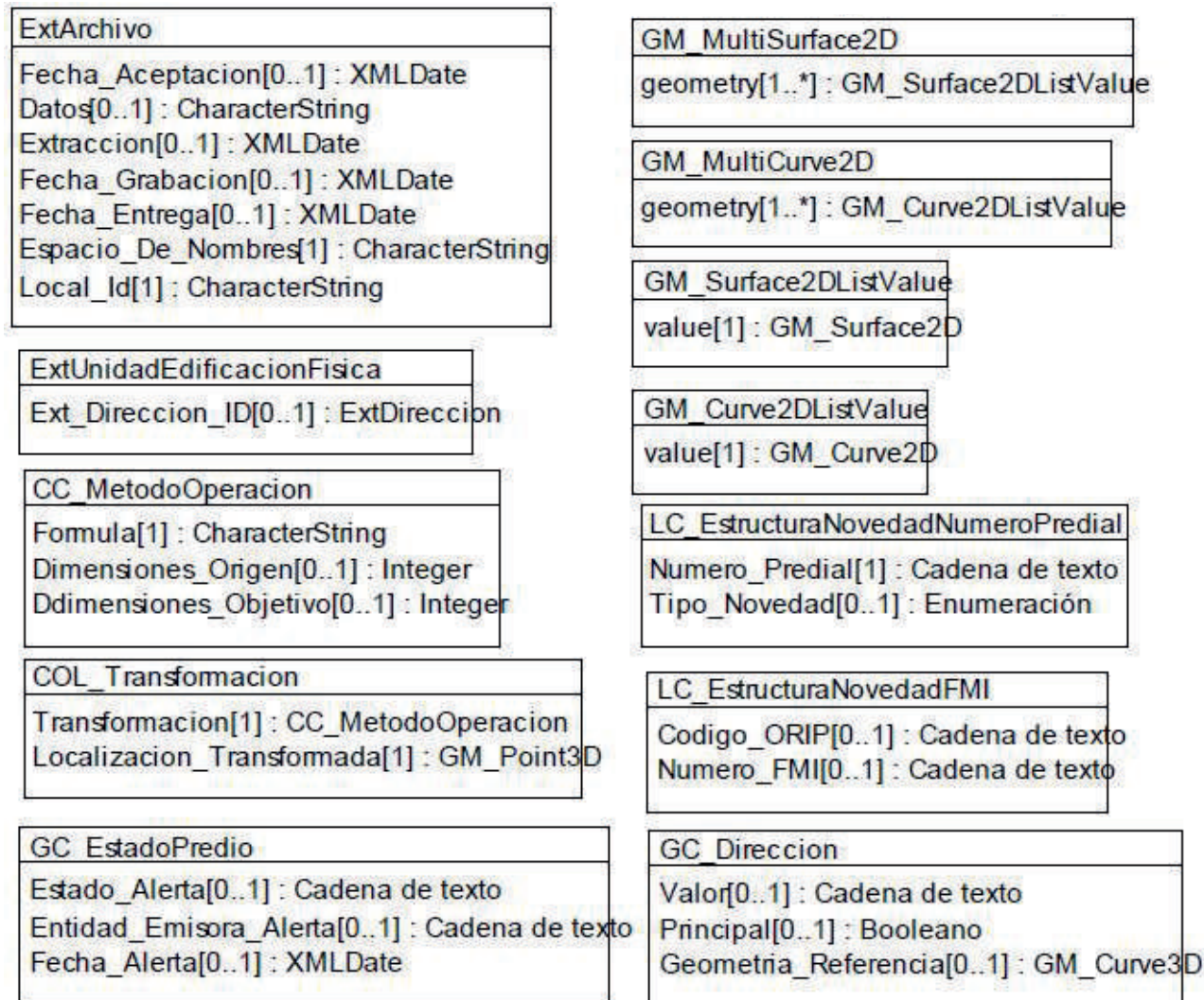


Figure 19. Structure Classes in MALC Version 1.0.

Source: IGAC (2021)

References

Agustín Codazzi Geographic Institute. (2023). Modelos LADM_COL. https://gitlab-ladm-col.igac.gov.co/root/LADM_COL/-/tree/master/Catastro_Multiproposito%20

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