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Land Administration Domain Model

Vol. 8:

Characterization of the Current Variables of the Extended Model Cadastre-Registration LADM-COL version 4.0

IGAC
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Land Administration Model - Colombia
Volume 8

ANALYSIS OF RELEVANT CHANGES TO THE LADM-COL EXTENDED MODEL CADASTRE-REGISTRATION

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Table of contents

Tables

Table of Figures

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).

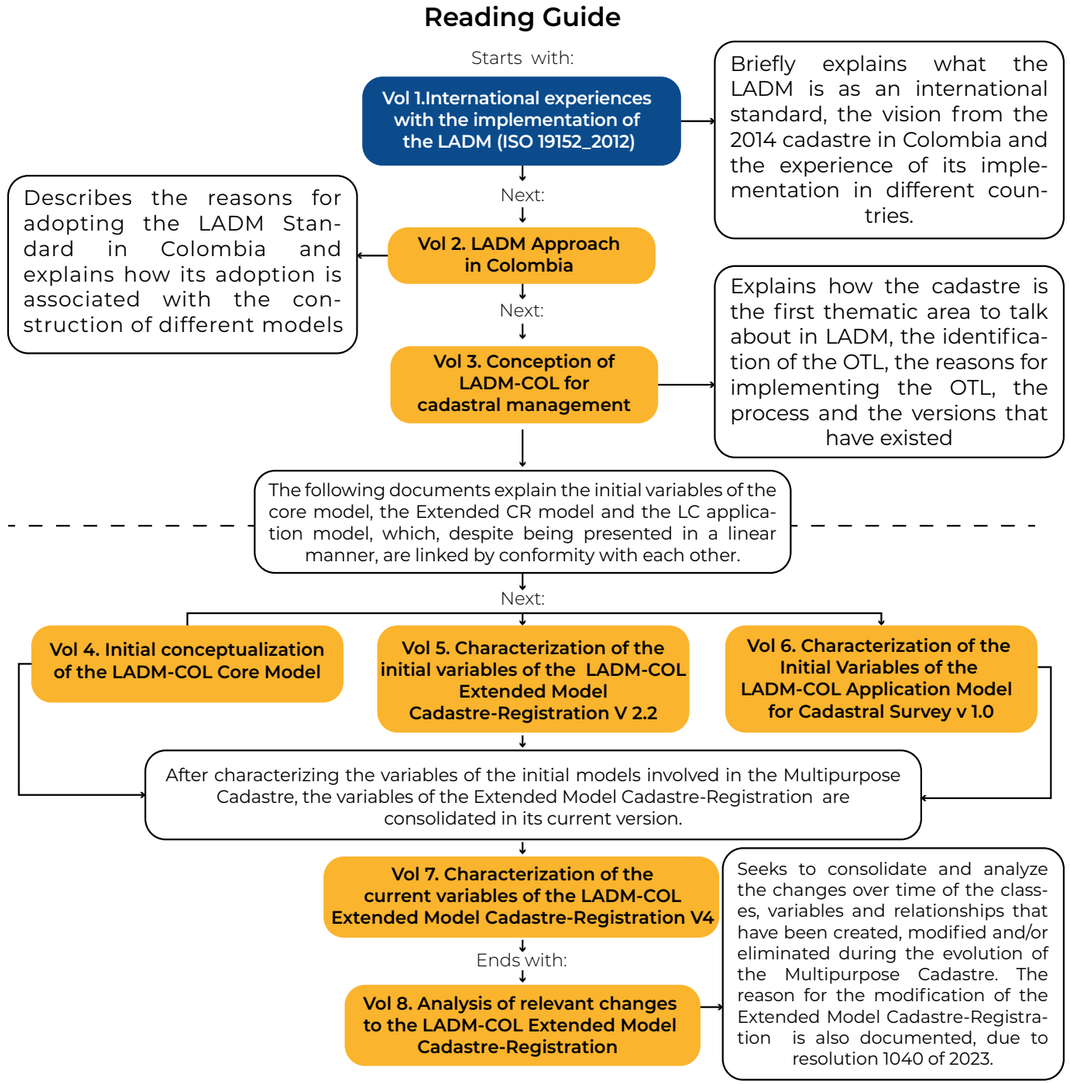


Figure 1. Reading guide for Documents Related to LADM Conceptualization in Colombia..
Fuente: elaboración propia.

Introduction

Within the framework of the LADM-COL standard, the extended model is defined as a specialization of the core model that incorporates a set of specific elements designed to satisfy the thematic needs of a specific legal land object in the field of territorial administration. In other words, it is an extension of the core model that includes additional thematic elements.

In the case of the LADM-COL Extended Model Cadastre-Registration (hereinafter, MECR by its acronym in Spanish), this standardizes and unifies the data model in relation to the cadastral and registry information, for which the property is the legal land object. This model must be in accordance with the core model so that interoperability with other sources of information is facilitated, as conceived in CONPES 3958 of 2019.

This text[1] compares the significant changes in the MECR throughout its various adopted versions (2.2., 3.2. and 4.0). All the packages, subpackages, and submodels that make it up are examined in detail, as well as their classes, structures, domains, and attributes. Therefore, the main objective is to provide a context on the evolution of this model extended over time.

Normative and contextual analysis

Based on the analysis and characterization carried out for the first version of the LADM-COL Extended Model Cadastre-Registration, designed for cadastral management with a multipurpose approach, it was possible to understand the true reason behind its creation. This model was conceived as an information

1 This document does not replace the model's documentation, such as its data dictionary, but rather illustrates part of the rationale for model changes.

storage system structured in UML language, initially oriented to the traditional cadastre, however, it was enriched with a set of variables considered relevant with the purpose of promoting cadastral modernization and opening new possibilities in the way that the Multipurpose Cadastre is used today.

For many years, the general perception of the modernization of the cadastre was limited to fiscal purposes; In a large part of the Colombian territory, municipal administrations, especially the treasury secretariats, used cadastral information mainly for the settlement of property taxes. This was the predominant model in most regions of the country. In response to this context, the Colombian State, in collaboration with international cooperation projects, undertook a research and analysis process to define the innovative concept known today as Multipurpose Cadastre. This approach sought to expand the usefulness of cadastral information in administration, planning, and territorial ordering, recognizing its fundamental role in territorial planning within the land administration system supported by the Cadastre.

Therefore, the cadastre was no longer considered solely for tax purposes and was consolidated as the basis for the management, planning, and administration of the territory in Colombia, supporting the modernization of official information systems within the framework of a state policy.

At that time, the purpose of the Multipurpose Cadastre was to provide updated data from the property census as input for decision-making in the planning and organization of the territory. However, changes in the administrative structure, modifications in roles, and rotation of the personnel involved distorted the original purpose. A new concept emerged that slowed down the process, as evidenced by several pilot projects that, although they provided precise results, were not efficient in terms of economic resources and execution times (IGAC, 2020).

The change in concept or misunderstanding is presumed prior to the year 2021, so it coincides with the beginning of the multipurpose approach to the cadastre. During the cadastral processes, additional variables were identified and

structured, such as the characterization of easements (in spatial terms and as types of restrictions) and the type of land according to territorial planning (urban, rural, and urban expansion). This evidenced a change in approach, considering the cadastre as an activity that collects information for multiple entities.

In consideration of the above, it was sought that, from the collection of cadastral information in the field, a greater number of external variables could be collected that would serve as input for other entities, thus interpreting and assuming this activity as the Multipurpose Cadastre. In other words, the aim was to collect as much information as possible during the cadastral processes, taking advantage of individual visits to the properties.

Furthermore, during the period of land modernization and cadastral processes prior to 2021, there were no technical documents that clarified the differences between the levels of conformity of the LADM-COL standard, nor did it have technical justifications for the governance of the core model. The lack of cohesion between the participating entities led to the massive cadastral processes (training and updating) being based on Resolution 070 of 2011 of the IGAC, without taking into account the multipurpose cadastre or the LADM-COL standard.

Resolution 388 of 2020 arose to make up for the absence of regulation and detail the way in which each cadastral manager, including the highest cadastral authority, should carry out the consolidation of the information collected (IGAC, 2020). However, said Resolution generated confusion regarding the implementation of cadastral management with a multipurpose approach and its relationship with the LADM-COL, since article 14 establishes that:

> **Article 14. Data model.** The result of the cadastral survey must be structured in accordance with the version of the model for the LADM_COL Cadastral Survey provided on the official IGAC website. (IGAC, 2020)

Considering the above, the LADM_COL cadastral survey application model is established as a standard for cadastral management and the delivery of the final product of the cadastral updating and training processes, leaving aside cadastral conservation (IGAC, 2020).

This model, as documented by the IGAC (2021), has the fundamental objective of establishing the standard for the minimum necessary variables intended to characterize the properties in the cadastral formation and updating processes.

This way, the aim is to achieve common semantics and a logical and organized structure, the purpose of which is to provide each cadastral manager the freedom to decide how to collect the physical, legal, and economic information of the properties, based on the model[2] proposal. However, it is important to highlight that the first point of the technical annex of the Resolution specifically establishes that the final cadastral database must be configured in accordance with the current LADM_COL cadastral survey application model and must be hosted in the INTERLIS language exchange, with XTF format.

When comparing the information provided in the technical documents and investigations of the IGAC with the requirements and guidelines established in the aforementioned Resolution, an apparent contradiction arises in the concepts and methodology of implementation of the LADM-COL standard for cadastral management. The above, because as has been mentioned throughout this series of documents, the IGAC has explained, communicated, and socialized through pedagogy, in its different media, talks, events, and presentations, among others, that the base, scheme, and/or structure of the data within the implementation of the Multipurpose Cadastre must respond to the LADM-COL Extended Model Cadastre-Registration.

In this sense, it is necessary to clarify that the LADM-COL Extended Model Cadastre-Registration can be modified or adapted to the reality of the proper-

2 It is important to note that there is no obligation to deliver the cadastral database exactly as defined by the structure of the model.

ties throughout the entire Colombian territory, so it does not refer to a specific application model; The reason behind its existence as a third level of compliance model is to allow each Cadastral Manager to adopt, adapt, generate and structure it according to the specific needs of its municipal jurisdiction, this includes considering the management, resources and systems present in said jurisdiction. In other words, the flexibility and customization capacity of the model is emphasized to adapt to the unique conditions of each geographic area and the available capabilities of local cadastral managers.

In 2021, when the LADM-COL model was already being properly discussed by the IGAC and the ICDE, Resolution 1149 was issued "By which the technical regulations for the formation, updating, conservation and cadastral dissemination are updated with a focus on multipurpose", which aims to: "Update the provisions on the cadastral formation, updating, conservation, and dissemination processes within the national territory, in order to establish and adopt a regulatory framework that guarantees the correct development of cadastral management with a multipurpose approach." (IGAC, 2021)

This Resolution largely repeals Resolution 070 of 2011, since that, although guidelines had been given on the products of the massive cadastral processes, these had not been regulated. This allowed the absence of a technical guideline on cadastral dissemination to continue as a new process within the Multipurpose Cadastre.

It is essential to mention the Resolution in question, given that it is related to the foundations of the application of the LADM-COL Extended Model Cadastre-Registration. However, when reviewing the entire administrative act, it is found that only article 66 superficially addresses the Data Model, as it indicates that:

> **Article 66. Preservation of cadastral information.** Los gestores catastrales deben garantizar la preservación, recuperación y acceso de la información catastral vigente e histórica, sin importar el medio o soporte en que se encuentre. Igualmente, deben implementar las tecnologías de la información y las telecomunicaciones, y mejorar los procesos catastrales para migrar, producir y conservar la información catastral siempre y cuando se sigan los estándares de interoperabilidad adoptados por el IGAC. Deberán adoptar de manera gradual el modelo de aplicación de levantamiento catastral LADM_COL en su versión vigente en sus sistemas de gestión para la realización de la operación catastral, sin perjuicio de que el Gestor Catastral adopte de manera complementaria otros modelos de aplicación LADM_COL de acuerdo a su necesidad." (IGAC, 2011).

Based on what is described in the article, it is ratified, almost a year after the issuance of Resolution 388 of 2020, that cadastral managers must progressively implement the LADM-COL Cadastral Survey Application Model in its current version. During that period, the model version evolved from 1.0 to 1.2, as detailed in the third volume of this series. This update involved changes in the structure and descriptive attributes due to the lack of productivity and benefits of version 1.0, as indicated by the IGAC in 2021.

The article specifies that all cadastral managers must use the Cadastral Survey Application Model as a basis for the assembly, development, or modification of their management systems. However, the contradiction persists, since it is reaffirmed that the standard model for cadastral databases is the LADM-COL cadastral survey application model, not the Extended Model Cadastre-Registration as expected.

Once the contradiction present during the initial implementation of the Multipurpose Cadastre in Colombia has been clarified, another important factor emerges that contributed to the bad experience of the pilot projects. The regulations included a survey and representation subpackage as a mandatory element for all the properties surveyed, which generated increases in execution times and costs since said information had to be generated and subsequently reported, in the event that the national entity that carried out the survey's ins-

pection, surveillance and control tasks for cadastral management, the Secretary of Notaries and Registry (SNR by its acronym in Spanish) will carry out an execution verification within the cadastral process.

During the development of this chapter, which belongs to the series of conceptualization and scientific documentation documents of the LADM model in Colombia, written by the IGAC, we seek to provide explanatory support for the changes that have occurred in the Extended Model Cadastre-Registration throughout the years.

Finally, it is important to emphasize that those interested in exploring and reviewing the changes, modifications, incorporations, and other relevant elements in the process of adopting the LADM-COL model for cadastral management can access the official IGAC website. On this platform, all the documents that are part of this documentary series are published, providing a comprehensive source of information on the evolution and development of said model in the cadastral context.

Why are the existing classes of the LADM-COL Extended Model Cadastre-Registration eliminated, added, modified, or complemented?

To enter into the discussion about the reasons that motivated the modification of the LADM-COL Extended Model Cadastre-Registration from its beginnings to its current version, it is necessary to consider the implementation process of the Multipurpose Cadastre. The model arises in response to the need to have an interoperable and unified data structure; In this context, the IGAC proposed to document in this series of primers the initial characterization of the first version of the model, followed by a detailed comparison of the level of classes, attributes and relationships.

The first version adopted by an administrative act was version 2.2, designated as the official core model of the MECR since the Resolution of its adoption; however, it is important to highlight that this version corresponds to the LADM-COL Extended Model Cadastre-Registration. This model was structured as follows (Figure 2) (Annex 1):

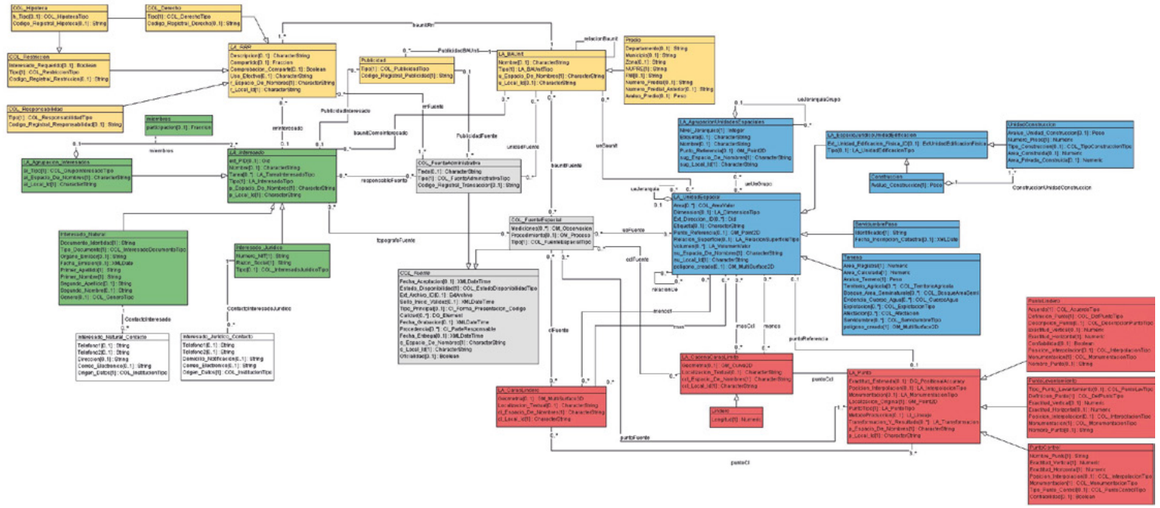


Figure 2. Main Structure of the Extended Model Cadastre-Registration Version 2.2
Source: IGAC (2023)

Additionally, the analysis focused on the comparison of the initial variables with the variables of a version preceding the current one. This approach is due to the fact that the LADM-COL Extended Model Cadastre-Registration, in its version 3.2, was in circulation and implementation for a period of a year and a half. During this time, version 3.2 served as a reference in numerous cadastral update processes in Colombian territory. The structure of this model is as follows (Figure 3; Appendix B):

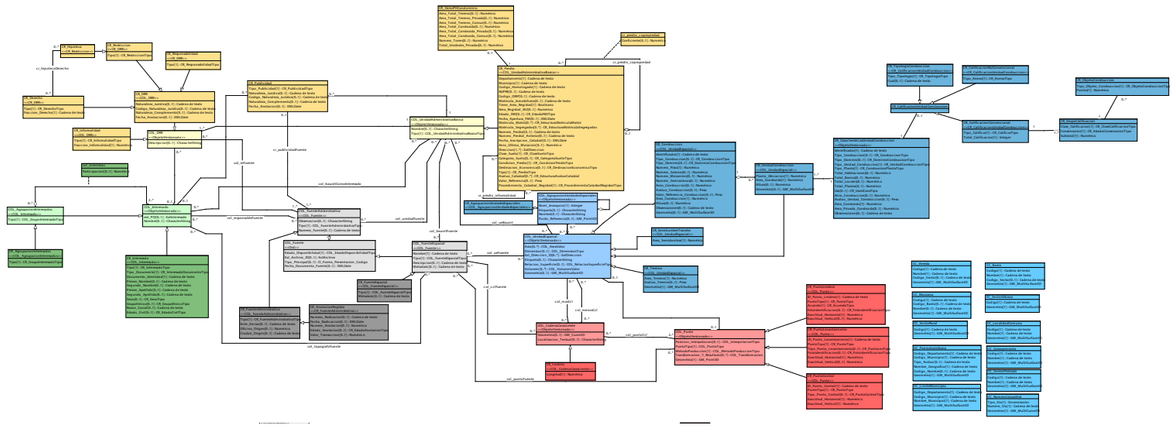


Figure 3. Main Structure of the Extended Model Cadastre-Registration Version 3.2.
Source: IGAC (2023)

Furthermore, as the analysis progresses, the technical reasons that gave rise to an internal discussion will be found until reaching a consensus for the formulation of the final version. The current version of the MECR is 4.0, shown below (Figure 4; Appendix C):

Review of the changes to the MECR by packages in its different versions

To observe the changes, a package-by-package verification of the model will be carried out, making a joint analysis of the changes that existed between version 2.2 and version 3.2, as well as between version 3.2 and the current 4.0.

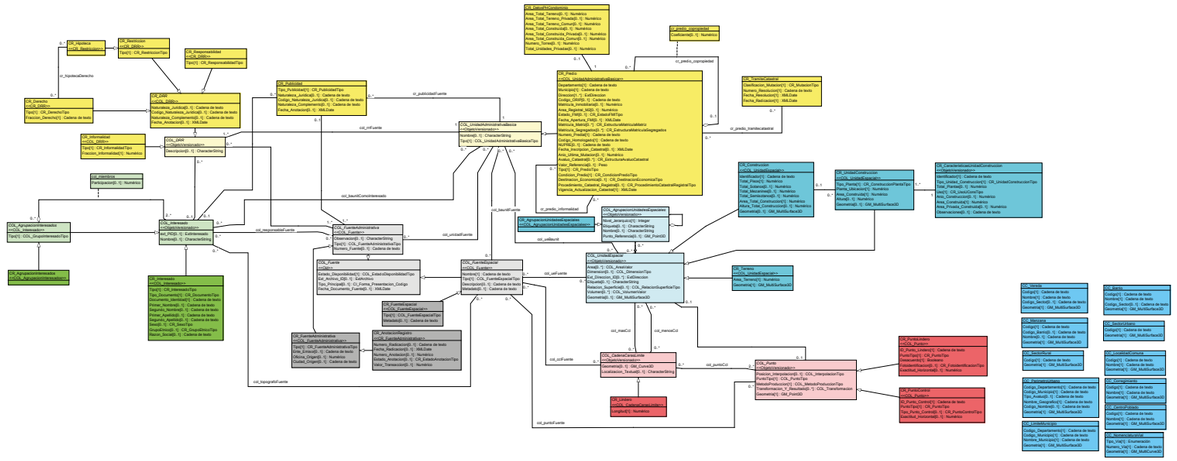
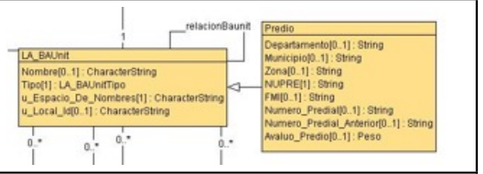
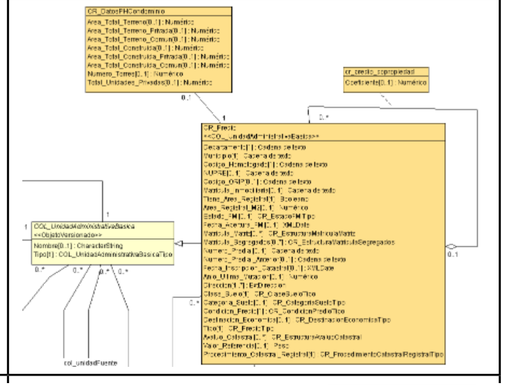
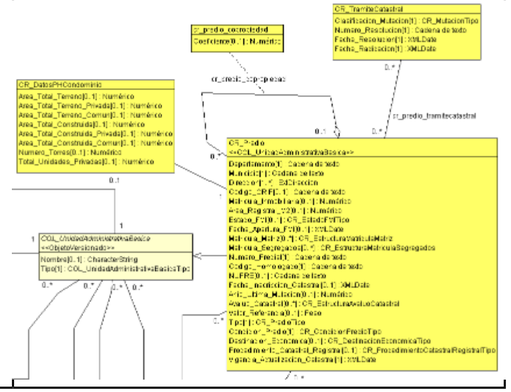


Figure 4. Main Structure of the Extended Model Cadastre-Registration Model Version 4.0.
Source: IGAC (2023)

Administrative package

Basic Administrative Unit. The administrative package is identified with the color yellow and is divided into two parts: the interested party package and the basic administrative unit package (Table 1).

Table 1. Changes in the Administrative Package (Basic Administrative Unit) Within the MECR in its Different Versions

Extended Model Cadastre-Registration Version	Graphic representation
Version 2.2	
Version 3.2	
Version 4.0	

In version 2.2, the administrative unit was not in accordance with what was established in the core model, evidenced in the class LA_BAUnit; likewise, between version 2.2 and 3.2, the classes CR_DataPHCondominio and CR_predio_copropiedad were incorporated, which show the details of this type of property, as well as the participation of the co-ownership coefficient; In version 2.2 the Predio (Property) class lacked certain attributes necessary for an adequate interrelation with the SNR, however, these are added in version 3.2.

The most notable transformation between version 3.2 and 4.0, as mentioned in one of the preliminary texts, lies in a notable change in the tonality of the displayed classes. To justify this modification, it is crucial to refer to the documents generated and published by the Colombian Infrastructure for Spatial Data (ICDE by its Acronym in Spanish). As the entity with governance over the LADM-COL core model, the ICDE established the guidelines so that the predominant colors in the extended models LADM-COL coincide with those that govern the new version of the LADM-COL Extended Model Cadastre-Registration.

Another notable change between these two versions is the introduction of the CR_TramiteCatastral class. The name of this class intuitively suggests its purpose, since it seeks to define the minimum variables necessary to characterize the procedures and/or mutations that each property experiences within cadastral management. The reason behind the creation of this new class is found in the issuance of Resolution 315 of 2022 by the IGAC.

In said resolution, a mechanism is established for the periodic delivery of information in order to consolidate all the cadastral data of the different managers in the National Cadastral Information System (SINIC). For this purpose, the IGAC implemented an application model that has been explained and supported throughout this series of documents. It is essential to mention this context to understand the origin and justification for the inclusion of this class.

This application model is known as Cadastral Information Report (RIC by its acronym in Spanish), which was created following compliance with the structure of the Extended Model Cadastre-Registration LADM-COL in its version 3.2, but which has its own classes within their focus or purpose for which they were created. Among these is the class RIC_TramiteCatastral. It was in this context where the purpose of this class was first thought of, since being an application model for the bimonthly information report, as stated in Resolution 315 of 2022, it is important to know the details that occurred within the processes. of cadastral conservation of each of the cadastral managers, which is why an attempt is made to characterize the conservation process based on the delimitation of the main data of the procedures completed during the period, such as the type of mutation, the date of filing, the number of the resolution that supports the procedure and the date of issuance of said resolution.
When the conservation characterization was devised, it was initially proposed within an application model, however, during the implementation of this model, the need arose to incorporate the same class within the MECR LADM-COL. The reason behind this decision is that the purpose of this model is to establish the minimum elements necessary to characterize a property, therefore, it is crucial to have a class that delimits the main data of the procedures that have caused changes in the cadastral information during management.
On the other hand, the basic administrative unit Predio has had some changes between these two versions, that is, a modification in its attributes, types, and/or mandatory nature. Among these, it can be found that the first change occurs in the real estate registration since it was structured under a data type of a text string and in the new version said data is numerical, with the purpose of achieving data interrelation between the cadastre and the registration, so all those real estate registration numbers that have alphabetical data or that belong to the old registry reference system must be updated by the SNR as one of the commitments acquired during the modernization of the administration of lands and formulation of the Multipurpose Cadastre.

In version 4.0, those attributes that were defined in previous versions as attributes for confirming the existence of data disappear, something that is characteristic of their Boolean type; However, the reason for its elimination is based on the completion of the fields as proof of existence. Not having the field can be stated as a lack of information, reducing the number of attributes to be completed and taking into account for the generation of application models. Among these attributes is Tiene_Area_Registral as the only attribute with that condition within version 3.2.
Another important change is the definition of the Property Number as mandatory for all properties, given that the model characterizes properties both physically and legally. It is essential to have this identification key for all registrations.
In line with the above, the complete elimination of the Previous Property Number is observed in the structure of the Extended Model Cadastre-Registration LADM-COL in version 4.0. This elimination is justified to break with the traditional information reporting schemes and not consider this field as mandatory, necessary or visible, adapting to the modernization of cadastral management.
For the basic administrative unit property, the attributes called Clase_Suelo y Categoria_Suelo are eliminated from its content, with everything they entail, and the reason for this is that the Land Category variable does not correspond to a direct jurisdiction of the cadastre, and the land class It is the one that was named as a variable specific to territorial planning that, in the same way, can often be identified from another attribute such as the property number.
An attribute that was decided to be added to the new model is the effective date of the cadastral update of the properties since with this information it is possible to determine the specific areas where the massive processes have been carried out, especially when thinking that the new cadastral regulations allow a partial Cadastral update to be carried out in the territory [3].

3 The cadastral update can be carried out partially in the territory, that is, in an area defined in accordance with the definition of different technical criteria.

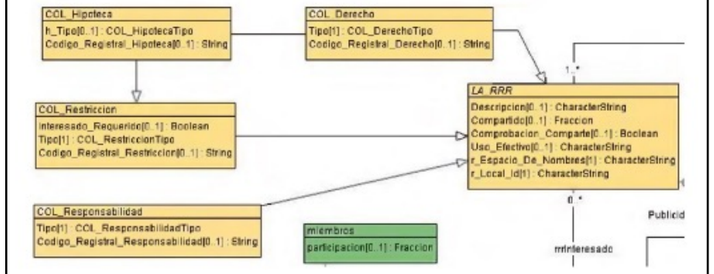
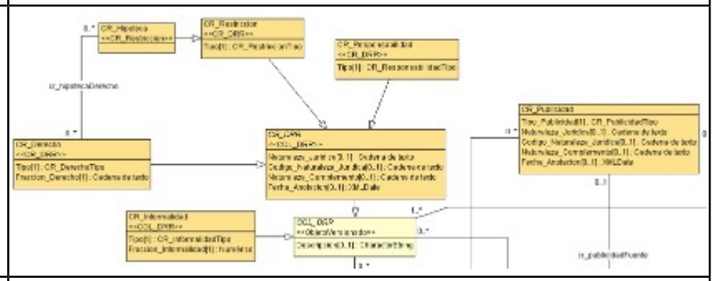
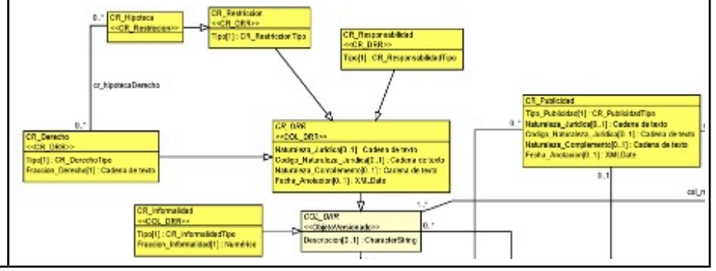
Regarding the Tipo or Dominio tables, the Fiscal and Patrimonial types were unified in version 4.0, eliminating common lands, vacancies, and collective territories. Additionally, a new type called Predio.Publico.Publico was created to identify properties that cannot be visually distinguished through a general folio review.

The CR_EstadoFMITopo table underwent a slight change in version 4.0, as two additional options were added that were considered in collaboration with the SNR. These changes demonstrate the adaptability of the model to the needs and agreements that emerged in the joint work tables.

Rights, Restrictions, and Responsibilities. In version 2.2, the classes, for the most part, were associated with the core model with the prefix COL, which was corrected in version 3.2, adjusting it with the prefix CR to reflect that these classes are specific to the Extended Model Cadastre-Registration LADM-COL. In version 2.2, the class related to rights, restrictions, and responsibilities, called LA_RRR, was not in accordance with the core model and defined attributes that did not guarantee the correct definition of the legal nature of the property. Furthermore, the informality class was not available, which meant that, if this condition existed, it was not possible to represent it.

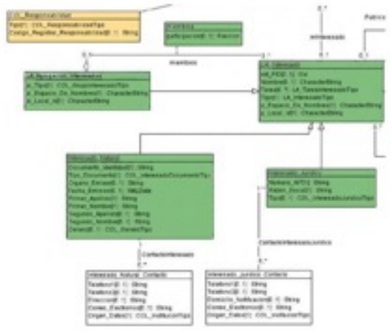
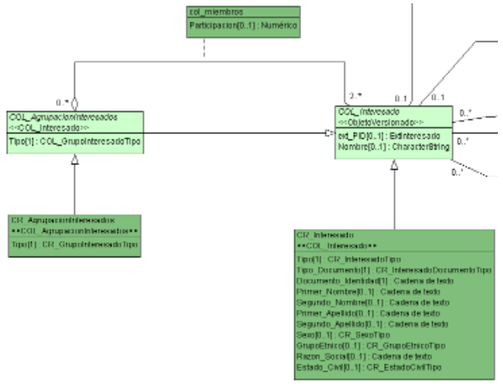
As for the package, it does not present changes or modifications from version 3.2 to 4.0 in any of its aspects. The same happens for the Tipo or Dominio tables related to those displayed. This lack of changes is due to the fact that this package is where the SNR intervenes the most since they are responsible for defining and managing the rights, restrictions, and responsibilities on the properties, and although the cadastre has undergone a process of modernization and change of focus, the SNR continues to perform its functions and store its data in the same way (Table 2).

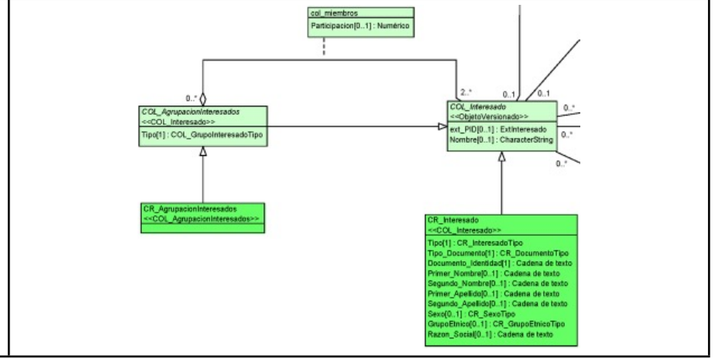
Table 2. Changes in the Administrative Package (Rights, Restrictions and Responsibilities) Within the MECR in its Different Versions

Extended Model Cadastre-Registration Version	Graphic representation
Version 2.2	
Version 3.2	
Version 4.0	

Party package. The second package corresponds to those interested in the LADM-COL MECR. To facilitate its understanding, its evolution in the different versions that have been adopted is shown below.

Table 3. Changes in the Party Package Within the MECR in its Different Versions

Extended Model Cadastre-Registration Version	Graphic representation
Version 2.2	
Version 3.2	

Extended Model Cadastre-Registration Version	Graphic representation
Version 4.0	

In version 2.2 the classes LA_Interesado and LA_Agrupacioninteresados do not comply with the core model, therefore, in version 3.2 some of the attributes of these classes are eliminated and the prefix COL is assigned to them, as well as to the class miembros, which is part of the core model and stores the percentage of participation in a property when said condition applies. In version 2.2, the class interested in legal and natural person was also separated; however, in version 3.2 this error is corrected by defining an attribute that determines the type of interested party, and the classes that came with it are merged. of the previous model.

In relation to the modifications from version 3.2 to 4.0, two significant changes in its characteristics are identified. First of all, the elimination of the attribute called Type, belonging to the domain CR_GrupoInteresadoTipo, is carried out. This decision is based on the elimination of duplication of information, since said attribute can already be found and characterized within the main class that comes from the core model, called COL_AgrupacionInteresados.

As for the class that refers to the interested party, an attribute called Estado Civil (marital status), present in version 3.2 but absent in the current version,

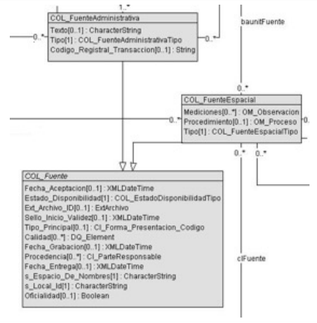
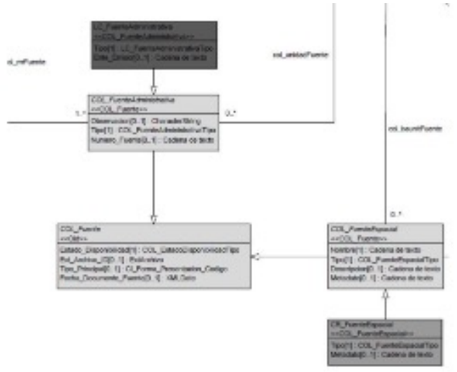
has been eliminated. This decision was made because the inclusion of this variable did not add significant value to the quality of the cadastral information, but its presence increased costs and time, since identifying this characteristic required a friendly conversation during property visits, therefore, this information could not always be obtained, especially when indirect methods were used.

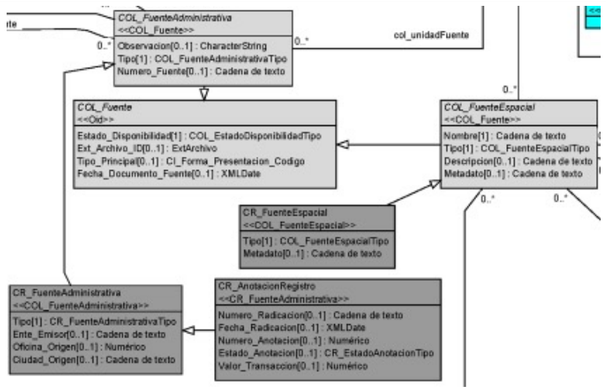
Document package. The document package responds to the need to store the documentation that supports the domain rights, the interested parties of the properties, and other actions related to them.

Between version 2.2 and 3.2, significant changes are observed in the COL_Fuente class, since some attributes that are not included in the original class of the core model are eliminated. In addition, new classes are introduced that refer to the CR_AnotacionRegistro and the CR_FuenteAdministrativa, which are associated with the initial information present in the core model.

On the other hand, between version 3.2 and 4.0, no changes are recorded in the document package. This fact confirms that the modeling conceived at the beginning of the formulation of the LADM-COL Extended Model Cadastre-Registration Model met the minimum characteristics to identify each of the supports that allow the identification of the properties.

Table 4. Changes in the Document Package Within the MECR in its Different Versions

Extended Model Cadastre-Registration Version	Graphic representation
Version 2.2	
Version 3.2	

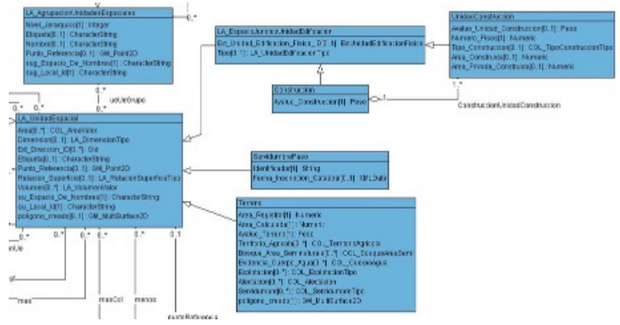
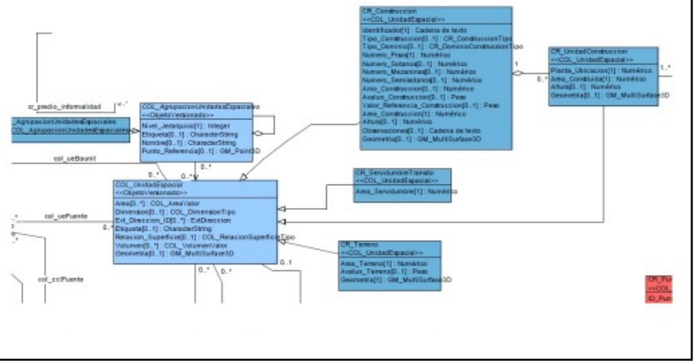
Extended Model Cadastre-Registration Version	Graphic representation
Version 4.0	

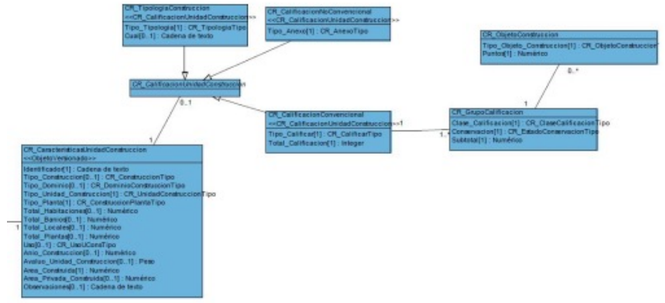
The next package that will be analyzed corresponds to the spatial one, which seeks to identify, through geometric representations, the main classes of the buildings and land, as well as their characteristics.

Spatial Unit package

In this package, various modifications are observed from version 2.2 to 3.2. In principle, the classes LA_AgrupacionUnidadesEspaciales and LA_UnidadEspacial, coming from the core model, receive the prefix COL to differentiate them from other classes. In addition, the class LA_EspacioJuridicoUnidadEdificacion is eliminated, since it is not necessary in the extended model. This is because the type of building and/or construction is characterized within the CR_Construccion class in version 3.2.

Table 5. Changes in the Spatial Unit Package Within the MECR in its Different Versions

Extended Model Cadastre-Registration Version	Graphic representation
Version 2.2	
Version 3.2	

Extended Model Cadastre-Registration Version	Graphic representation
Version 4.0	

In version 2.2, the Terrain class included attributes such as Territorio_Agricola, Bosque_Area_Seminatural, Explotación, Afectación, Evidencia_Cuerpo_Agua, which are characteristics of other extended models, such as the one issued by the Ministry of Housing, City and Territory for Territorial Planning Plans, and other models related to natural areas under the responsibility of the Ministry of Environment and Sustainable Development. Additionally, the Servidumbre attribute was eliminated, since there is a class related to this information; however, in version 4.0, this class is eliminated, which does not affect the property right over the property.

Changes are also observed from version 2.2 to 3.2 in the Construction class, in which attributes are associated that allow characterizing the construction, such as Tipo_Construccion, Tipo_Dominio, Numero_Pisos, Numero_Sotanos, Numero_Mezanines, Numero_Semisotanos, Anio_Construccion, Valor_Referencia_Construccion, Area_Construccion, Altura, Observaciones y Geometría. Additionally, the CR prefix is added to the class to indicate its origin from the Extended Model Cadastre-Registration.

Likewise, modifications from version 2.2 to 3.2 are presented in the class UnidadConstruccion. The CR prefix is added to clarify its origin and it is defined

as a parent class of the CR_CaracteristicasUnidadConstruccion class, associating general attributes such as Planta_Ubicacion, Area_Construida, Altura y Geometría, along with various attributes to characterize the building units in the inhered class.

In addition, from CR_CaracteristicasUnidadConstruccion the class CR_CalificacionUnidadConstruccion is derived, which in turn is the parent class of the classes CR_TipologiaConstruccion, CR_CalificacionNoConvencional and CR_CalificacionConvencional, in the latter the class CR_GrupoCalificacion also emerges from which CR_ObjetoConstruccion is derived, so in version 3.2 it is achieved the complete characterization of the building units. However, as will be explained later, the qualification of building units is removed in version 4.0 because this detail promoted complexity in the model.

Concerning the modifications made to the spatial unit from version 3.2 to 4.0, significant changes were introduced related to the relationship between buildings and building units. In version 3.2, it was stated that constructions must exist to support the existence of a building unit, which implied a mandatory relationship, however, in version 4.0, this relationship was no longer mandatory and became optional.

This modification is based on the understanding of individual concepts related to what a construction represents, the construction can be seen as the footprint of the building on the ground, the union of all building units, or even as the general polygon that encompasses the entire built area of a property. When implementing the Multipurpose Cadastre, greater relevance was given to the building units as main representations to identify the built area. This perspective sought to achieve a detailed identification by the floor of each building unit, with the long-term vision of modeling a 3D Cadastre, as stated in the document Catastro 2034 presented by the FIG at one of its annual events.

Another substantial change is due to the elimination of the CR_ServidumbreTransito class in the Multipurpose Cadastre. This decision is supported by the argument that the cadastre should not deviate from its central purpose, which

is to serve primarily as a real estate census. In other words, the aim is to avoid the collection, processing and management of information that is not relevant to the main mission of the cadastre, as is the case of easements.

The elimination of this class is justified because this additional approach increases the execution times and costs of the process; It is argued that an extremely robust legal team would be needed to carry out the analysis and study of detailed titles for the identification and characterization of these easements.

However, with the new rules and principles of the cadastral processes, defined in Resolution 1040 of 2023, the aim is to synthesize and be as concise as possible within the massive processes, which responds to the national government's goal of achieving an updated, massive, fast and effective cadastral registration throughout the territory.

The most significant change, which occurred between the publication of version 3.2 and the future publication of version 4.0 of the Extended Model Cadastre-Registration, was the elimination of the classes linked to Calificación de la Construcción (construction qualification). Initially, these classes and attributes were defined through the consensus of all cadastral managers, including the IGAC, which was based on the experience derived from the execution of the Cadastral Formation and Update processes of the traditional cadastre.

With respect to the economic aspect of the properties, the qualifications or typologies, as they were known, were considered elements of great relevance to determine the cadastral valuation of the properties, in addition, they allowed us to differentiate the reason for the value of the construction, calculated from the defined score for the materials used in them. For this reason, when modeling and structuring a database according to the LADM-COL standard for the administration, provision and exchange of information, the idea of having standardized qualifications and/or typologies for all properties was incorporated.

However, after a period of implementation of this model, experts in the

characterization of the economic aspect of the properties [4] raise the discussion on the suppression of elements based on two principles of cadastral management. These principles, known as legal independence and methodological freedom, are contemplated in Decree 148 of 2020 issued by the Departamento Administrativo Nacional de Estadística –National Administrative Department of Statistics– (DANE by its acronym in Spanish), and seek to ensure that cadastral managers implement in their management systems and process manuals the methodology that best suits your needs and preferences for the execution and development of massive cadastral processes, without prejudice to altering the final product, which is the cadastral database.

This is why, by incorporating these classes and attributes into a database structuring standard, together with the lack of clarity in the cadastral regulations at that time, the actors involved could interpret that the section related to construction qualification must be completed during the collection of information in mass processes. This could lead to the application of a direct methodology, since the qualifications, both conventional and non-conventional, require presence in the territory because they are based on the identification of materials and the state of conservation of a construction.

For this reason and in line with the aforementioned principles of cadastral management, the IGAC collects the comments presented in the service and contact channels, analyzes and verifies them; Subsequently, it determines the purpose promoted by the interveners, which is the request for the elimination of these classes because they contradict two of the fundamental principles in the creation of the Multipurpose Cadastre.

In response to this, the IGAC proceeds to remove these elements during the process of modifying the LADM-COL Extended Model Cadastre-Registry and promotes, in its training sessions, the adoption of various methodologies

4 Process that culminates in the determination of the cadastral valuation.

so that each of the interested actors can present and execute their proposals.

As a fourth change related to this very significant package, which addresses spatial representation, we proceed to the elimination and modification of attributes within each of the independent classes. In this context, the classes and attributes that have undergone modifications will be detailed individually, with the purpose of describing these changes precisely.

CR_Terreno. The removal of the aforementioned attribute is justified in a similar way to the removal of the construction qualifications section: at that time, it was considered that requesting this field or maintaining it as an attribute within the Land class, could lead to cadastral managers to adopt a specific economic valuation methodology, such as homogeneous areas. In the review of the model, it was concluded that it was not necessary to have this value for all the land in a municipality; as a result, in version 4.0 of the LADM-COL Extended Model Cadastre-Registration, the field was eliminated (Table 6).

Table 6. Changes in the CR_Terreno Class of the Spatial Unit Package Within the MECR

Attribute	Datum type	Obligatoriness	Description of the change
Avaluó Terreno (Land Valuation)	Peso	0..1	The named field is removed from the table

This attribute has generated debates among experts, as some see it as essential within comprehensive property identification, while others see it as redundant information, but this attribute will be addressed later in the following discussion section. Although version 4.0 of the LADM-COL Extended Model Cadastre-Registration does not incorporate it, the technical specifications of the new Resolution refer to it.

CR_Construccion. Within the spatial unit package, the class underwent significant modifications, which initially addressed the change in cardinality in the internal relationships and subsequently the attributional adjustments made (Table 7).

Table 7. Changes in the CR_Construccion Class of the Spatial Unit Package Within the MECR

Attribute	Datum type	Obligatoriness	Description of the change
Tipo Construcción (Construction Type)	Domain	0..1	The attribute is removed
Tipo Dominio (Domain Type)	Domain	0..1	The attribute is removed
Numero Pisos (Number of Floors)	Numeric	1	The name is modified to “Total_Pisos”
Numero Sótanos (Basements Number)	Numeric	0..1	Se modifica el nombre a “Total_Sotanos”
Numero Mezanines (Mezzanine Number)	Numeric	0..1	The name is modified to “Total_Mezanines”
Numero Semisótanos (Semi-basement Number)	Numeric	0..1	The name is modified to “Total_Semisotanos”
Año Construcción (Construction Year)	Numeric	0..1	The attribute is removed
Avaluo Construcción (Construction Valuation)	Peso	0..1	The attribute is removed
Valor Referencia Construcción (Construction Reference Value)	Peso	0..1	The attribute is removed
Area Construcción (Construction Area)	Numeric	1	The name is modified to “Area_Total_Construccion”
Altura (Height)	Numeric	0..1	The name is modified to “Altura_Total_Construccion”
Observaciones (Observations)	Text string	0..1	The attribute is removed

Regarding the elimination of the first two attributes mentioned, this decision is based on the redundancy of information stored in the class, said data can be obtained or calculated from other information already present in the same class, especially related to the use of construction; For this reason, it was deci-

ded to delete the Tipo and Dominio attributes of the construction, despite their presence in the cadastral base for several years. The modification of attribute names was made to improve the clarity and understanding of each one, since confusion had arisen due to the assigned names.

The elimination of the Año de la Construcción (Year of Construction) attribute was carried out after an extensive debate, based on the difficulty of obtaining this information in the cadastral processes, it was argued that the data is complicated to obtain, since the current owners of the properties have not always been present or aware of the development of the construction, often not knowing the exact moment of its construction.

However, another group of experts, linked to property valuation processes, defended the need to include the year of construction, as they argued that this data was crucial for determining the commercial valuation of a property since without this information it would not be possible to apply depreciation methods on construction materials; Therefore, it was recognized that this approach is part of the valuation methods applied in a cadastral formation and updating process.

This discussion has a significant impact by considering Construcción as a footprint on the land without discriminating uses, materials and other relevant elements, therefore, it should not be included in this discussion; However, in the analysis of one of the following classes, this attribute will be maintained, thus satisfying the discussion and presenting coherence with the other attributes that characterize it.

In the change analysis, two attributes were identified that characterized similar elements: Avalúo de la construcción (Construction Valuation) and Valor de Referencia de la Construcción (Construction Reference Value). To address the need for their removal, it is crucial to understand the nature of each one. Thus, it is important to remember that the reference value corresponds to the estimated commercial value for that construction, while its valuation will be the cadastral valuation obtained from said commercial value.

Based on the above, it was considered pertinent to eliminate both attributes, since the inclusion of a field called Avalúo Construcción (Construction Valuation) was suggesting the need to use methodologies that separated the valuation of the land from that of the construction, this limited those who wanted to apply methods that involved an integral value, since they did not have a place to store said data, apart from the cadastral valuation per property.

The interpretation was initially not correct, since at no time was the possibility of modifying the MECR LADM-COL to create application models denied, but these confusions were clarified with the continued publication of these documents.

CR_UnidadConstruccion In the analysis of this class, it is crucial to observe how the plant type appears as a field referring to a Tipo or Dominio table. When identifying that these building units reflect the building by floors and use, it is essential to recognize the type of floor that will be represented spatially, since this attribute can take values such as floor, mezzanine, basement, semi-basement and underground, in accordance with the definition established in the elements of the Tipo table (Table 8).

Table 8. Changes in the CR_UnidadConstruccion Class of the Spatial Unit Package Within the MECR.

Attribute	Datum type	Obligatoriness	Description of the change
Tipo Planta (Floor Type)	Domain	1	The attribute that responds to the type of building unit that is being spatially identified is added

CR_CaracteristicasUnidadConstruccion. To begin the analysis of this class, it is crucial to understand what it refers to and why it is included in this model. According to the definition in the data dictionary of the LADM-COL Extended Model Cadastre-Registration, it is described as the “Class that allows building units to be grouped by identifier, use and typology”, so this is a class without

geometric representation that It encompasses building units (floors and uses) with the purpose of unifying what could be understood as a building unit. In other words, it represents the construction that shares similar characteristics, either in terms of typology and/or use, regardless of its extension or height (Table 9).

Table 9. Changes in the CR_CaracteristicasUnidadConstruccion class of the spatial unit package within the MECR

Attribute	Datum type	Obligatoriness	Description of the change
Tipo Construcción (Construction Type)	Domain	0..1	The attribute is removed
Tipo Dominio (Domain Type)	Domain	0..1	The attribute is removed
Tipo Planta (Floor Type)	Domain	1	The attribute is removed
Total Habitaciones (Total Rooms)	Numeric	0..1	The attribute is removed
Total Baños (Total Bathrooms)	Numeric	0..1	The attribute is removed
Total Locales (Total Commercial Units)	Numeric	0..1	The attribute is removed
Avalúo Unidad Construcción (Building unit Valuation)	Peso	0..1	The attribute is removed

This analysis has similarities with the one presented in the CR_Construccion class; the type of construction and domain were eliminated due to their excess of information and little relevance in this identification. The type of plant was eliminated since it was added in the corresponding class, in addition, the attributes that stored data that had historically been collected in the cadastre were deleted: rooms, bathrooms, and commercial units.

Although these characteristics of the buildings had always been collected and managed for the cadastre, in discussions at several work tables with the SNR and other entities, it was concluded that this information did not contribute significantly to the identification of the economic component. Furthermore, there

was no certainty about the reliability of this data, since, for the cadastre, this information was considered additional data that was collected but rarely useful.

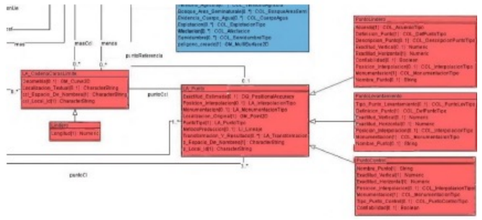
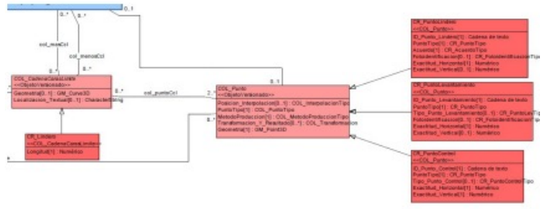
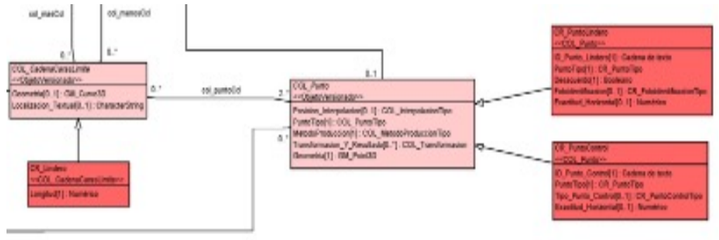
Some experts argued that these features were useful for generating basic statistics; However, it was decided that understanding in detail the composition and distribution of the construction was not the responsibility of the cadastre, but the importance of knowing the use and destination of the construction was recognized. The last attribute that underwent a modification within the class was the valuation by building unit, whose justification lies in the fact that, by having a field to store a cadastral value for use, the implementation of specific valuation methodologies was being suggested to obtain said value. This would affect the principle of methodological freedom and, therefore, it was considered necessary to make the corresponding modification.

To conclude the analysis of this class, it is important to highlight that the Año Construcción (construction year) attribute will be retained, since after reviewing and justifying the changes that this class experienced, it is understood why this attribute should be and remain within it. CR_CaracteristicasUnidadConstruccion stores common information by use and/or typology of a construction; Therefore, it is crucial to know when it was built, since it is considered a building unit or, in other words, a complete construction with similar characteristics, this allows the economic component to determine its commercial value and, subsequently, its cadastral value, if that is what the methodology defines.

Surveying and Representation Subpackage

The Surveying and Representation Subpackage is part of the Spatial Unit Package, but responds to some main ideas such as the correct delimitation of the properties in Colombia; its different versions are shown below (Table 10).

Table 10. Changes in the Surveying and Representation Subpackage Within the MECR in its different versions

Extended Model Cadastre-Registration Version	Graphic representation
Version 2.2	
Version 3.2	
Version 4.0	

Regarding the changes made in this subpackage from version 2.2 to 3.2, modifications were made to the classes LA_CadenaCarasLimite and LA_Punto, these classes were renamed with the prefix COL to facilitate the understanding of their origin concerning the core model. In addition, the LA_CarasLindero class was eliminated because its implementation generated greater workloads without providing significant data for the operation of the extended model.

Likewise, the CR prefix was added to the PuntoLindero, PuntoLevantamiento, and PuntoControl classes to identify them as part of the Extended Model Cadastre-Registration. Within these classes, some attributes that are not functional for the topographic representation of the properties and that could generate delays in the associated cadastral processes were eliminated.

Regarding the changes from version 3.2 to 4.0, one substantial modification and several small ones stand out. Firstly, the CR_PuntoLevantamiento class was eliminated, since in version 3.2, this class sought to characterize each of the points that delimited construction; However, it was considered unnecessary for the cadastral process, since the purpose of the Multipurpose Cadastre focuses on identifying land and property constructions, so it is more relevant to identify the boundaries of the land than those of the constructions since the latter They are often determined by indirect methods. Having this class would lead to carrying out a cadastral survey to obtain information about each of the properties, which would generate an increase in costs and execution times in the cadastral processes.

Additionally, minimal changes were made that included the elimination of an attribute related to vertical accuracy, since after reviewing the cadastral processes and considering methodological freedom, it was determined that it was not appropriate to request a field that would require a field survey. Therefore, eliminating this attribute had no significant impact on cadastral identification and was in line with the necessary methodological flexibility.

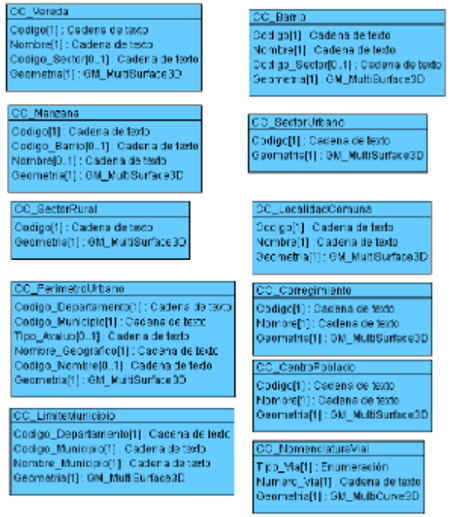
Cartography submodel

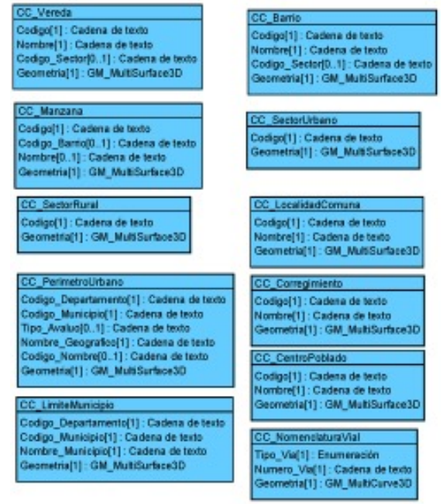
The cartography submodel is a complement to the Extended Model, and its understanding can be addressed according to Decree 148 of 2020. This sub-

model incorporates non-parcel layers that contribute to property identification in Colombia, so its identification is essential since these layers act as inputs for cadastral and other processes.

Also, it is important to note that this submodel was not present in version 2.2, but is later represented in versions 3.2 and 4.0 (Table 11).

Table 11. Changes in the cartography submodel within the MECR in its different versions

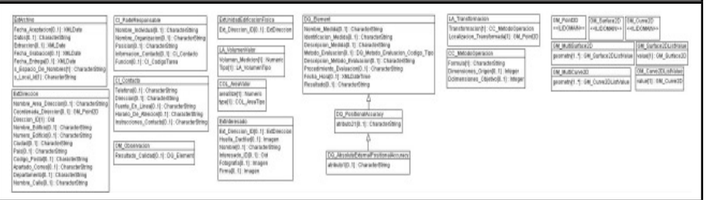
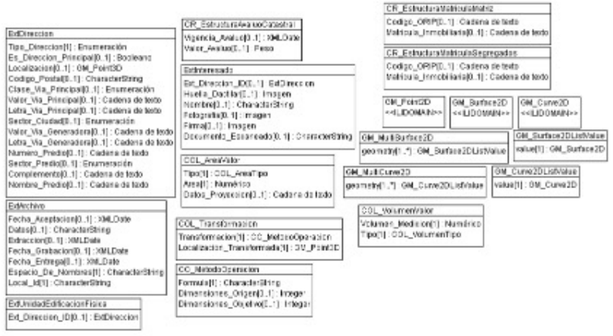
Extended Model Cadastre-Registration Version	Graphic representation
Version 3.2	

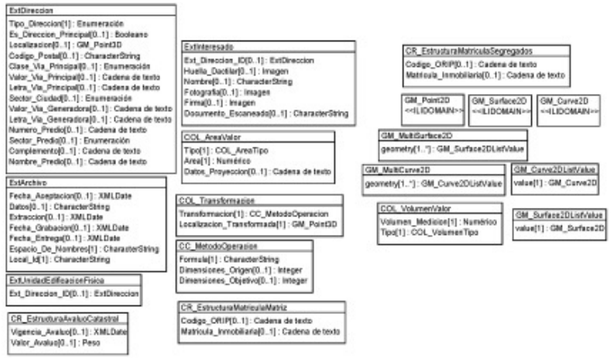
Extended Model Cadastre-Registration Version	Graphic representation
Version 4.0	

For this submodel, there are no changes to its classes, so it is stated that it is the best way to characterize these elements that are not main in the cadastre but are important for property identification.

Structure tables. Finally, the set of elements that make up the fundamental structures and information in the LADM-COL MECR will be verified, which in addition to all the submodels, packages, and subpackages detailed above, are fundamental elements within cadastral management with a multipurpose approach (Table 12).

Table 12. Changes in the Structures Within the MECR in its Different Versions

Extended Model Cadastre-Registration Version	Graphic representation
Version 2.2	
Version 3.2	

Extended Model Cadastre-Registration Version	Graphic representation
Version 4.0	

Regarding the structures shown in version 2.2 of the model and 3.2, substantial changes include the elimination of CI_ParteResponsable, CI_Contacto, OM_Observacion, ExtInteresado, DQ_Element, DQ_PositionalAccuracy, and DQ_AbsoluteExternalPositionalAccuracy, in addition to the inclusion of the structures CR_EstructuraAvaluoCatastral, CR_EstructuraMatriculaMatriz, and CR_EstructuraMatriculaSegregados, which are derived from the changes in the attributes of each of the associated packages, subpackages, and submodels; in addition to including the changes in the prefixes of the structures coming from the core model from LA to COL, in order to maintain the conformity of the model and provide clarity of its origin.

In relation to versions 3.2 and 4.0, for this set of tables and/or crucial elements in property characterization, no changes or modifications were recorded between the different versions of the model. For this reason, the analysis of changes and their justifications is concluded in comparison with the previous version of the LADM-COL Extended Model Cadastre-Registration (3.2), which was in force for a long time during the implementation of the Multipurpose Cadastre in Colombia.

All of the above closes the detailed analysis of the reasons and needs that led to the modifications in the LADM-COL Extended Model Cadastre-Registration during the last year, the IGAC and the SNR led it through joint working groups held after June 2022. Finally, it culminated in the publication of version 4.0 in December, which is hosted in the data repository managed by the ICDE[5].

With this publication, the IGAC intended to provide transition times between versions, which is why it was decided to launch it in December, allowing each cadastral manager to adapt their management systems to the new structure in the following six months. In addition, managers were encouraged to generate their own application models.

This document details the discussions raised regarding the current model and, during this year, situations have been identified that justify certain minimal modifications. It is expected that, with these adjustments that will be discussed in the next chapter, it will be possible to have the minimum variables necessary to identify a property in Colombia without prejudice to an early modification of the extended model, as happened with version 4.0.

Discussion related to the new guidelines for the implementation of the LADM-COL in multipurpose cadastral management

To introduce this chapter, it is necessary to generate a context about the regulatory modifications that occurred in 2023 in multipurpose cadastral management. In this sense, the first step involves pointing out that some of the resolutions considered in this document, and others not specifically addressed, were completely repealed due to the new regulations. These regulatory changes refer specifically to the following administrative acts:

- IGAC Resolution 070 of 2011

5 The link to enter the online repository is the following: https://gitlab-ladm-col.igac.gov.co/root/LADM_COL.

- IGAC Resolution 1055 of 2012
- IGAC Resolution 1008 of 2012
- IGAC Resolution 829 of 2013
- IGAC Resolution 789 of 2020
- IGAC Resolution 388 of 2020
- IGAC Resolution 1100 of 2021
- IGAC Resolution 1149 of 2021
- IGAC Resolution 267 of 2023
- IGAC Resolution 782 of 2023

The repeal of these administrative acts that, to a greater or lesser extent, were part of the current regulation for cadastral management, presents a significant advantage. This lies in the compilation and organization of the provisions related to the processes, procedures, and products of cadastral management, now with a multipurpose approach. This change is materialized through Resolution 1040 of August 8, 2023, which issues a single resolution for multipurpose cadastral management.

The purpose of the Resolution establishes the central purpose of the document, outlining the themes and areas of knowledge addressed throughout its content. In this sense, it is noted that:

> **Article 1.1. Object.** The purpose of this resolution is to establish the cadastral management regime with a multipurpose approach for the adoption of model 50 of cadastral management and operation, define the conditions for enabling and disabling cadastral managers, regulate the cadastral management processes, determine the specifications database techniques, the adoption of the guide for the development of quality plans in cadastral training and updating and forming the Technical Advisory Body for Cadastral Management. (IGAC, 2023)

To achieve the goal of issuing Resolution 1040 of 2023, it is necessary to go back to the beginning of this year. Then, the IGAC directors brought together experts who must have the relevant knowledge and experience to carry out an exhaustive diagnosis and identify possible flaws, inconsistencies and contradictions present in the Multipurpose Cadastral management regulations.

With the intention of taking advantage of the time during the discussions and agreement processes of the Plan Nacional de Desarrollo (National Development Plan) in the Congreso de la República (Congress of the Republic), the IGAC leaders decided to launch this group of experts to consolidate all the related guidelines and directives in a single document. with the processes and products of cadastral management with a multipurpose approach. These aspects were discussed over the years and, despite attempts with new administrative acts to address flaws, inconsistencies and/or gaps in the regulations, new questions continually arose.

Consequently, for four months, this group of experts discussed and proposed new ideas to improve cadastral regulations in relation to cadastral processes and products, as the days progressed, the route that was wanted to be established in a single administrative act issued by the entity became clear. The main objective was to incorporate as many concepts, processes, procedures, principles and other key elements as possible necessary to guarantee optimal provision of the public cadastral service, as well as compliance with the goals established by the President of the Republic of Colombia.

Once the process that led to the new cadastral regulation throughout the Colombian territory was understood, the framework of the discussions and solutions generated in the process of formulating the standard was explored, therefore, when addressing the definition of technical specifications of products of cadastral management, the need arose to consider the LADM-COL standard and its relationship with the process. For this reason, the discussions, questions and answers that arose in this group of experts during the analysis and formulation of the technical concept of the new Resolution are presented.

To explore the content of the Resolution, the articles will be cited and what is relevant will be highlighted to provide context for the documented situation.

Article 1.6. responsibilities and competencies in multipurpose cadastral management

This article will discuss the responsibility of the IGAC as the highest cadastral authority, which in literal d of section 1 indicates the following:

> **Article 1.6 Responsibilities and Competencies in Multipurpose Cadastral Management.**
> *(...)1. Agustín Codazzi Geographic Institute – IGAC.*
> (...) d. Consolidate the National Cadastral Information System -SINIC- or the tool that takes its place (...). (IGAC, 2023)

The reference to the SINIC and its relationship with the LADM-COL model is based on Resolution 315 of 2022 of the IGAC, which is currently in force, this resolution defines an Application Model for the LADM-COL Cadastral Information Report (RIC by its acronym in Spanish), with the purpose of facilitating the bimonthly delivery of data by all Cadastral Managers in the country, including the IGAC. The purpose of these deliveries is to consolidate a national information system[6] that stores the entire cadastral database.

In this context, Resolution 315 of 2022 establishes the guidelines and requirements for the standardization of the exchange of cadastral information, using the LADM-COL model as a reference. The specific citation of this article is made to highlight the relevance of this resolution within the framework of the process of discussion and formulation of the new regulations, which incorporates and

6 This system is structured following the Application Model for the Cadastral Information Report LADM-COL (RIC, by its acronym in Spanish).

strengthens the relationship between the SINIC and the LADM-COL model.

Within the same article, but now talking about the responsibilities of the cadastral managers, literals c and d of section 2 indicate the following:

> **Article 1.6 Responsibilities and Competencies in Multipurpose Cadastral Management.**
>
> (...)2. Cadastral Managers
> (...) c. Carry out the report of cadastral information in the National System of cadastral information -SINIC- or the tool that takes its place.
> d. Implement the LADM_COL Extended Model Cadastre-Registration launched validity by the IGAC and the SNR (...). (IGAC, 2023)

In relation to the first paragraph cited and in line with the responsibility of the IGAC as the highest authority, it is established that all cadastral managers must ensure that their information, through ETL models and tools, complies with a structure defined by the Application Model for the LADM-COL Cadastral Information Report (RIC). As a second responsibility, cadastral managers must implement the LADM_COL Extended Model Cadastre-Registration; Therefore, this provision resolves confusion between existing rules and regulations[7].

The mandate is clear in specifying that the LADM-COL Extended Model Cadastre-Registration must be implemented in its currently current version 4.0, since it is explicitly established that all versions prior to version 4.0 are repealed and cannot be used in cadastral management with multipurpose approach.

7 It is important to note that up to this point we have only addressed the obligation to implement this model, without providing details on how or where to carry out such implementation.

Article 1.7. Procedures defined by managers and methods to apply

In summary, this article indicates that cadastral managers will be able to define the procedures and apply the methodology they wish (direct, indirect, collaborative and/or combination of these) as long as they respect the current LADM-COL Extended Model Cadastre-Registration. Without prejudice to confusion, the resolution clarifies the methodological and procedural freedom that since Decree 148 of 2020 has sought to promote in multipurpose cadastral management, with the aligned objective of complying with the cadastral update of the national territory by the end of the four-year period of the current government.

Article 1.9. Criteria for the interoperability of the National Cadastral Information System – SINIC

This article sets the standards for cadastral data and information for the interoperability and integration of data with all information systems. For this reason, section 1 of this article establishes that:

> **Article 1.9 Criteria for the Interoperability of the National Information System Cadastral mation - SINIC.**
>
> (...)2. Cadastral data and information standards. Common and mandatory data standards must be used for the capture, storage and transfer of cadastral data and information, in accordance with the current LADM_COL Extended Model Cadastre-Registration (...). (IGAC, 2023)

At this point, a clear structuring of the established guidelines is observed, since the notion of imposing the LADM-COL Extended Model Cadastre-Registration

in its exact form, as published on the official pages of the IGAC and the SNR, is abandoned. Instead, emphasis is placed on achieving conformity with this model in the storage of cadastral information, so this approach reflects the intention of the resolution to seek legal independence, encourage technological openness, and allow methodological freedom in implementation. of these guidelines.

Article 3.1.9. Technological solution

Within the cadastral authorization processes, the resolution establishes that applicants must present a detailed description of the comprehensive technological solution for cadastral management. The description must ensure that the standards for transferring cadastral information and the adoption of the current LADM-COL Extended Model Cadastre-Registration are met and applicants are expected to conform to other guidelines that will be defined by the MINTIC.

This requirement reinforces the idea that in the management systems and databases of cadastral managers seeking to become qualified, the adaptation or creation of technological solutions that adopt the model must be guaranteed.

mentioned, so it is important to highlight again that conformity with the model stands out over the need to replicate it identically, thus allowing some flexibility in implementation.

Article 3.6.2. Information to be delivered by the outgoing cadastral manager

When a cadastral disabling process is carried out, the outgoing manager must deliver his management information in accordance with the current version of annexes 3, 4 and 5 of the Resolution, so when reviewing said annexes it is found that:

- Annex 3. Minimum documentation for the resumption of the public service of cadastral management by the previous manager: in its section 2 “Final Cadastral Information Generated” it is mentioned that the alphanumeric and geographical database must be structured in the transfer application model of LADM-COL Cadastral Management, in the National Single Origin reference system and in XTF format (INTERLIS exchange format).

This process is where the importance of adopting and implementing management models that conform to the LADM-COL Extended Model Cadastre-Registration begins to become evident, since, if this is done correctly, the generation of ETLs or tools that transform data, to take it from one structure to another, it will be very simple, since the same core model is handled, the same extended model and only the existing application models will change.

- Annex 4. Cadastral Management Transfer Application Model LADM-COL V.1.0: in this annex it is possible to see the structure of the data scheme or model that is required for the delivery of cadastral information in disabling processes only.
- Annex 5. Data Dictionary Cadastral Management Transfer Application Model LADM_COL V 1.0: this document contains the definitions and characteristics of each class existing in this model, to make known and provide what is referred to in common language, following thus with the principle of transparency and involving the LADM-COL model for cadastral management.

This specific article introduces for the first time the LADM-COL Cadastral Management Transfer Application model and its relevance within the implementation of the Multipurpose Cadastre. The need to create and define this model in the regulatory document is explained by the absence of a prior data structuring, since until then, there was only talk of a cadastral authorization process, where the IGAC, as the highest cadastral authority, approved or rejected the authorization requests from the different territorial entities, so in case of approval, the IGAC, as administrator and provider of the public cadastral service, had to deliver the information in an exchan-

ge format in accordance with the current Extended Model Cadastre-Registration.

Although this process had been fulfilled until that moment by delivering structured information in XTF format during the splicing processes, structured under the input submodel of the cadastral manager which, in turn, is contained within the LADM Cadastral Survey Application Model-COL Since version 1.0, the creation of the cadastral disabling figure generated the need to have a new data structure. This structure had to be used so that the manager outgoing to the IGAC receives information, according to the LADM-COL Extended Model Cadastre-Registration, in addition, it had to comply with the additional requirements that the IGAC, as the highest authority and cadastral manager, would demand to reestablish the provision of the public service.

With the creation of this new application model, the inclusion of new classes and/or attributes was allowed that would make it possible to store all the information collected, characterized and arranged within the management system of each of the managers, regardless of its engine or manager. of databases.

This approach supports consistency in the implementation of the LADM-COL model in cadastral management processes with a multipurpose approach, as the functionality, purpose and focus of each level of conformity of the models is understood, limitations are gradually addressed. existing in the processes, although this progress has been justified, the need to continue examining the new articles that intervene with the LADM-COL model is recognized, which will continue to support the solution proposed in this regulatory framework.

Article 4.4.1. Characteristics of the dissemination process of cadastral information

A significant milestone within the Resolution under analysis is the regulation and definition of the cadastral dissemination process, a key aspect that had not been addressed in the previous regulations. Although the name of the

process suggests its objective, it is essential to provide it with a series of rights, duties, responsibilities, principles and other elements necessary for its correct development. For this purpose, we have sought to provide a focus and establish minimum guidelines that must be met in this process.

In section 5 of article 4.4.1, the following is established:

> **Article 4.4.1. Characteristics of the process of dissemination of cadastral information.**
>
> (...)5. Standardization. The process of dissemination of cadastral information implements standards for the exchange of data and information. For the dissemination of cadastral data and information, the current Extended Model Cadastre-Registration LADM_COL must be adopted and implemented, in order to ensure that data and information are presented in a coherent, uniform and understandable manner. In addition, the services, products and information metadata provided by cadastral managers must comply with the standards adopted by the ICDE. (...). (IGAC, 2023)

This article establishes that the dissemination of cadastral information must adopt and implement the current LADM-COL Extended Model Cadastre-Registration, whose objective is to guarantee that the data are presented in a coherent, uniform and understandable manner; In addition, the importance of complying with the guidelines for managing geographic information defined by the ICDE is highlighted, highlighting the need to maintain the coherence and integrity of cadastral information in the context of geospatial information.

Likewise, in section 6 of this article interoperability is named again as follows:

Article 4.4.1. Characteristics of the process of dissemination of cadastral information.

(...) 6. Interoperability. The cadastral information generated by the managers must be able to feed and integrate with the SINIC and with other information systems for the administration of the territory, through the adoption of the interoperability standards established by the MINTIC, the Extended Model Cadastre-Registration LADM_COL in force, and the cadastral dissemination strategies proposed in the operation model of each manager (...). (IGAC, 2023)

However, this section refers to the process of dissemination of cadastral information, so it is crucial to examine how the IGAC establishes that every cadastral manager must integrate and enrich the SINIC. This process will be carried out through the adoption of interoperability standards established by the MinTIC and the LADM-COL Extended Model Cadastre-Registration.

To this point, the articles that address and involve the LADM-COL data model in the context of cadastral processes, principles, responsibilities and fundamental concepts have been reviewed, however, the majority of the analysis of the Resolution focuses on the Title V, which defines the technical specifications of the multipurpose cadastral database product. This aspect will be addressed in detail below.

Article 5.1.7. Data structure and content

This article details the structure that the cadastral database with a multipurpose approach must have, specifying that it must conform to the current version of the MECR LADM-COL, using its data dictionary as a guide. Furthermore, the possibility for each cadastral manager to define their LADM-COL application models is reaffirmed, as long as they take the Extended Model as a reference.

The intention of this article seems to be to clarify that the IGAC establishes

a minimum characterization standard, allowing each manager to implement new application models according to their specific needs. Examples mentioned in the document include the possibility of creating an application model exclusively for collecting images of facades and structures, designed for use in mobile developments for field work, or even an application model dedicated to storing and characterizing the economic component of the premises.

The flexibility to have several of these models according to the decision of each manager is established, as long as compliance with the current LADM-COL Extended Model Cadastre-Registration is maintained, so the regulations adapt to change and continuous learning during the implementation of the Multipurpose Cadastre and the adoption of the LADM in Colombia. It is recognized that the current version is not the definitive version of the Extended Model, since needs may arise that require its modification or adaptation to address the elements necessary to identify a property in Colombia.

Article 5.2.1. Physical component information

It is important to highlight that this article defines general minimum characteristics that will contribute to characterizing the physical component of the properties, including the area, number of floors, use, state of conservation and year of construction of each building unit, and are considered the boundaries and boundary points of the objects, which will be analyzed in greater detail later.

When reviewing the MECR LADM-COL in its current version, there are already variables such as the number of floors, use, year of construction, boundaries and boundary points, but others mentioned, such as areas and state of conservation, are not explicitly characterized within of the model. This shows the need for modifications in the extended model, which will be addressed in this document.

Article 5.2.3. Area information

This article addresses the consideration of two different areas of land for the characterization of the properties. It is highlighted that these areas are conceptualized independently depending on the condition of the property. In the model, it will not be necessary to explicitly store the area for those properties that have a geometric representation of their land, a particular case of properties in specific conditions such as NPH, PH Matriz, Condominio Matriz, Parque Cementerio Matriz (Cemetery Park Matrix), Via (Road), Uso Público (Public Use) and Predio informal (Informal property).

To obtain this data, if necessary, the geometry of the polygon within the extended model will be used, which must be represented and georeferenced with the CTM12 National Single Origin spatial reference system, however, for properties in conditions such as PH Unidad Predial (PH Property Unit) or Parque Cementerio Unidad Predial (Park Property Unit Cemetery), the area will be reflected from the co-ownership coefficient defined in the horizontal property regulations and the geometric area of the corresponding parent property.

In the case of a Condominio Unidad Predial (Property Unit Condominium), the geometric area of the land will be the sum of the geometric representation area of the private land and the common area, calculated from the horizontal property regulations, the co-ownership coefficient and the geometric area of the land of the property matrix.

Then, the notion of *land cadastral area* is introduced, which will be incorporated into the database according to the instructions of the document. This data identifies the area necessary for cadastral and tax purposes and will depend on developments within the property or if the difference between the geometric area of the property and the current cadastral area of land exceeds the tolerance range defined in the Resolution.

It is crucial to highlight that in the current version (4.0) of the LADM-COL Extended Model Cadastre-Registration there is no specific field to store the geometric area of the land, since it seeks to avoid fields calculated or obtained from others; However, the introduction of this new area highlights the need for modification and adaptation of the model to address this specific aspect in property identification.

Article 5.2.4 Physical component attributes

This article highlights the specification of the characteristics of the Building unit element, where the request for the State of Conservation is included as an attribute of this component. As already said, this characteristic is not included in the LADM-COL Extended Model Cadastre-Registration and this request stands out as a second justification for modifying the model, so the state of conservation must be incorporated as one of the attributes of the class corresponding to the building units.

This is to have a clear and justified record of the current status of the building unit, which is crucial to determine a commercial value, if necessary, for this unit.

Article 5.2.6. Spatial Representation

The content of this article defines the type of representation of properties in Colombia, which will be a vector model supported by the LADM-COL Extended Model Cadastre-Registration. In addition, it specifies the classes that must have this spatial representation, which are:

- Punto Control
- Punto Lindero
- Lindero

- Terreno
- Unidad de Construcción

In relation to the boundaries, the line-type vector spatial representation is defined from the boundary points, expressed in meters, while, for the boundary points and control points, the point-type geometry is established, seeking to reflect both the characteristics physics such as the position of these elements.

It is important to note that the article does not mention the class that corresponds to the construction, known as CR_Construction. This agrees with the analysis of changes carried out in the document, which indicates that said class is no longer mandatory, the main representation of the constructions of the properties must be characterized in the Building units, as described previously.

Article 5.3.1 Information on the legal component

The LADM-COL Extended Model Cadastre-Registration covers all the minimum variables to characterize properties, but the need to document this special article is due to the perception that, although the legal nature of the property is contemplated in the legal elements, this attribute is not is present in the model. The legal nature of the property is reflected in the characterization of the Property Type, defined within the structure of the model.The reference to Legal Nature is used here to facilitate understanding and clarity of the regulations, using a more commonly used term.

Article 5.4.1. Economic component information

The purpose of this article is to establish the fundamental elements for the economic characterization of the properties. In this context, new elements are introduced that are not contemplated in the LADM-COL Extended Model Cadastre-Registration, which constitutes the third and final justification for the modification of the model itself.

These elements are:

-Valor Comercial
-Valor Comercial Terreno
-Avalúo Catastral Terreno
-Valor Comercial Unidades de Construcción
-Avalúo Catastral Unidades de Construcción

The definition of the mentioned elements is in the content of Resolution 1040 of 2023 and is crucial because it demands a modification of the aforementioned Extended Model. During the formulation of this regulation, the group of experts collaborated closely with the representatives of the economic component of the IGAC properties, so they expressed the need to incorporate fundamental variables in the work tables, especially when storing the information that supports the calculation of the cadastral valuation of the property.

The presence of these variables in the technical product specifications of the database resulting from the cadastral processes drives the inclusion of these new variables in the aforementioned extended model. This ensures that the database scheme covers all the relevant variables, thus characterizing all the components that are part of the property in Colombian territory.

Conclusiones

This document has managed to detail and argue the processes that led to the modification of the Extended Model Cadastre-Registration, from its initial version 2.2, through the changes made in the intermediate version 3.2 until reaching its current version 4.0. This represents the documentation of the traceability ne-

cessary to consolidate a database scheme that guarantees the interoperability and integration of the multipurpose cadastre, framed in the implementation of a Territory Administration System (SAT, by its acronym in Spanish) in the country.

The lessons learned during the implementation of the multipurpose cadastre highlight the need for adaptation and modification of the LADM-COL Extended Model Cadastre-Registration. This evolution seeks to achieve more efficient and precise cadastral management, complying with the accuracy that the multipurpose cadastre pursues, in response to the agreements established in Havana, Cuba, in 2016.

The implementation of a new data model based on an international standard has been a considerable challenge, marked by numerous discussions and conflicts between national entities. Through this document, we seek to clarify concepts and transmit the role of the IGAC as the highest cadastral authority and pioneer in this process, as well as the experiences and needs that drive the adoption of a new implementation methodology. The objective is to make cadastral information compatible and understandable with other sources of information provided by various entities.

In the last three years, numerous modifications have been observed in a standard designed to ensure data integration. These modifications not only depend on the IGAC, since the governance of the LADM-COL Core Model is the responsibility of the ICDE. It is essential to note that, in this implementation process, the IGAC has been the first "learner", as it has faced discrepancies that have motivated the arguments presented in this document. The objective is for the community and other entities to understand and adopt the LADM -COL and its compliance levels to ensure that all the information collected culminates in a comprehensive knowledge of the real estate census and other thematic areas of the land administration system in Colombia.

This set of documents highlights the importance of documenting all the agreements and disagreements that have arisen around the LADM-COL over the years, this is done to understand why it has been necessary to have a group of experts on the subject. to advise and guarantee the implementation of the Model

in the multipurpose cadastre; Furthermore, the need to propose new ideas for the management and transfer of knowledge is highlighted, as the IGAC has done during its years of management since implementation.

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