

Coordinated Adoption of LADM_COL in Colombia: Intersectoral Governance for the Multipurpose Cadastre

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SUMMARY

Colombia has made significant progress in implementing the Land Administration Domain Model (LADM) standard through a country profile known as LADM_COL. This article presents a structured overview of the adoption process and inter-institutional governance of the standard, which has led to the consolidation of a reference data model for multipurpose cadastre management and land data administration in Colombia. Through coordination led by the Colombian Spatial Data Infrastructure (ICDE), three levels of conformance were established: a core model (national), extended models (for each basic administrative unit), and application models (for specific purposes). These are being progressively adopted by the institutions responsible for land data and are supported by the development of regulatory frameworks that enable their implementation. The article describes the evolution of the standard's adoption, the public consultation process, and the mechanisms for alignment with international standards, highlighting the challenges and opportunities for effective implementation. This experience provides key lessons on the adoption of common models in complex institutional contexts and in scenarios where data governance is a critical factor for interoperability. The Colombian case may serve as a reference for other countries facing similar challenges in integrating land-related data under principles of standardization and sustainability.

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1. INTRODUCTION

Land administration requires integrating information produced by entities with diverse competences (Lemmen, 2012). When such information is generated under fragmented regulatory frameworks and data structures, institutional efficiency, legal certainty, and the State's decision-making capacity are reduced (Paasch et al., 2015). Overcoming these limitations requires a common conceptual framework and mechanisms that ensure interoperability between systems (ISO, 2012).

For this purpose, the International Organization for Standardization (ISO) adopted in 2012 the ISO 19152 standard, which defines the Land Administration Domain Model (LADM) (ISO, 2012). This standard provides a shared language to represent relationships between people, spatial and administrative units, based on rights, restrictions, and responsibilities (RRR) (Lemmen, 2012). Its adoption seeks to facilitate institutional integration and interoperability and the development of national land administration systems that are more transparent, coordinated, and sustainable (van Oosterom, 2018).

Colombia has made significant progress in its implementation through the Colombian country profile of LADM (LADM_COL), conceived not only as a technical modeling tool but also as a strategy for inter-institutional coordination. This process has consolidated a reference data model for territorial data administration in the country, extending to key aspects such as multipurpose cadastre management, land use planning, and the identification of collective property territories of Indigenous and Black, Afro-Colombian, Raizal and Palenquero communities (NARP, for its acronym in Spanish), among others.

The model is implemented in three levels of conformity: a core model with common structures, extended models that specialize legal territorial objects (LTO), and application models adapted to operational purposes. This hierarchy combines standardization and flexibility, recognizing the institutional diversity of the country (IGAC, 2024).

The governance of the LADM_COL standard and of the core model lies with the Colombian Spatial Data Infrastructure (ICDE), which coordinates its validation and evolution (ICDE, 2022). Nevertheless, the adoption process has been complex and gradual, since it involves not only technical challenges but also regulatory and institutional transformations. Tensions persist in sectoral appropriation, the definition of competences, and the management of technical capacities (IGAC, 2024a).

This article examines the Colombian experience in adopting LADM_COL, with emphasis on intersectoral governance, the achievements, and the pending challenges. Its analysis seeks to provide useful lessons for other countries moving toward land administration systems based on international standards.

2. NATIONAL POLITICAL FRAMEWORK

In Colombia, the cadastre and the land registry have historically been separate functions, assigned respectively to the Instituto Geográfico Agustín Codazzi (IGAC) and the Superintendence of Notary and Registry (SNR). In addition, the notion of cadastre has traditionally been restricted to the property cadastre, with predominantly fiscal purposes. This institutional and functional separation has hindered the articulation of different territorial information sources, limiting their use for administrative, legal, or planning purposes (DNP, 2019a).

The consolidation of the Multipurpose Cadastre in Colombia has been promoted through public policy as part of an effort to modernize territorial management and improve decision-making based on information. Its orientation was defined in CONPES Document 3859 of 2016, which established technical, institutional, and financial guidelines for the implementation of a cadastre integrating the physical, legal, and economic dimensions of land management, property, and land suitability, with a differential, updated, and multipurpose approach. Subsequently, CONPES 3958 of 2019 deepened the necessary strategic actions, including institutional strengthening and the adoption of a standardized data model to serve as the basis for a National Cadastral Information System and, in perspective, for a Land Administration System (LAS).

The regulatory reform accompanying this policy enabled the decentralization of cadastral management. Law 1955 of 2019 (National Development Plan 2018–2022) introduced the possibility for entities other than IGAC to assume cadastral functions by creating the figure of the cadastral manager, defined as the public or mixed entity authorized by IGAC to establish, update, maintain, and manage cadastral information within a specific territorial scope. At the same time, the role of the cadastral operator was regulated, understood as the legal entity providing technical support services to managers, always under their responsibility. Finally, Decree 148 of 2020 regulated the framework of cadastral management, including the procedures for authorization, operation, supervision, and control of managers, thus closing the framework for decentralized cadastral management.

This opening highlighted the need for a shared technical and semantic framework to ensure interoperability among diverse actors. In this context, IGAC and SNR, in an initial effort to officially adopt the LADM standard, issued Joint Resolution IGAC 642 and SNR 5731 of 2018, with the aim of aligning the conceptual structures of the cadastre and the land registry and laying the foundations for a common and standardized data model.

Through this resolution, the first extended model was adopted: the Extended Cadastre-Registry Model (MECR), the first of several models to be subsequently developed. This model specializes the LADM_COL core to represent legal territorial objects associated with property and other legal situations concerning land. At this initial stage, responsibility for the model's evolution lay exclusively with IGAC, as the national cadastral authority and technical lead of the process (IGAC, 2024b).

However, with the progress of the Multipurpose Cadastre and the expansion of institutional responsibilities in territorial data administration, it became clear that the LADM_COL standard required a higher-level technical body for governance, one that would move beyond the initial focus solely on the property cadastre. In this context, the ICDE with more than 25 years of experience as the national coordination body for geographic information, formally assumed the role of coordinating the development, validation, and adoption of the extended

and application models of LADM_COL (ICDE, 2022). This transition in leadership reflected a shift in approach: from centralized technical control to a broader governance scheme, in which the competent entities for different legal territorial objects (LTO, as will be presented later) participate in the evolution of the LADM_COL standard based on shared principles. In sum, the regulatory and public policy framework not only enabled the adoption of the Multipurpose Cadastre, but also required the construction of a common and standardized semantics for territorial data, leading to the adoption of LADM_COL as the structural reference model to consolidate an interoperable and sustainable LAS.

3. GOVERNANCE OF LADM_COL

The governance of the LADM_COL standard is framed within ICDE, a national body that evolved over more than two decades and consolidated as the authority responsible for coordinating its adoption, development, and implementation

3.1 ICDE Background

The evolution of the ICDE did not result from a single regulatory act, but from a progressive process of institutional maturation. Its origin can be traced to inter-institutional cooperation initiatives from the early 2000s, including Agreement No. 1 of 2000, signed by a group of public and private entities¹, which laid the foundations for coordination on geographic information. Subsequently, CONPES Document 3585 of 2009 formulated the National Policy on Geographic Information and identified the ICDE as the body for technical and institutional coordination. Although it did not grant it legal status, it recognized the ICDE as a public policy initiative and designated the Instituto Geográfico Agustín Codazzi (IGAC) as the coordinating entity.

In 2015, Decree 1170 regulated the administrative sector of statistical information, including guiding principles of the National Statistical System (SEN), which also apply to the ICDE.

In 2019, Decree 2404 modified Decree 1170 and formally created the ICDE in its Article 2.2.3.5.6, granting it a purpose, administrative structure, and coordination functions with the SEN.

Later, Resolution 460 of 2022 of the Ministry of ICT (MinTIC) issued the National Data Infrastructure Plan and its roadmap, in which the ICDE was integrated as part of the government data infrastructure ecosystem.

IGAC Resolution 899 of 2023(a) provided the ICDE with its own regulatory framework by specifying its governance structure and the coordination responsibilities among entities, in addition to establishing guidelines for geospatial data interoperability and quality.

3.2 ICDE Composition

Resolution 899 of 2023, which regulates the structure and functioning of the ICDE, defines it as a set of technologies, policies, standards, and institutional plans designed to facilitate the

¹ National Administrative Department of Statistics (DANE), IGAC, Institute of Hydrology, Meteorology and Environmental Studies (IDEAM), Ecopetrol, DNP, Ingeominas, and the National Federation of Coffee Growers.

access, generation, and use of spatial data in coordination with the National Statistical System (SEN).

In terms of governance, it establishes two main governance bodies:

- Intersectoral Geographic Information Commission (CIIG): the highest advisory body, composed of the Director of IGAC, the Director of DANE—who presides over it—, the Director of DNP, the Minister of MinTIC, and the Commander of Air and Space Operations of the Colombian Air Force (FAC), or their delegates.
- Technical Operational Committee (CTO): responsible for the technical and operational implementation of the CIIG’s decisions.

Resolution 1524 of 2024, issued by the DNP, does not alter this structure, but strengthens the operational role of the CIIG by designating the Directorate of Territorial Planning and Development (DODT–DNP) as its Technical Secretariat.

3.3 Functions and Responsibilities of the ICDE regarding the LADM_COL

The role of the ICDE in relation to the LADM_COL standard goes beyond the general coordination of geographic information and is specified in the governance of its adoption, validation, implementation, and evolution. This role was expressly defined in ICDE Agreement 002 of 2023, through which the Intersectoral Geographic Information Commission (CIIG) established guidelines for the management of the model.

In this agreement, the ICDE assumes key responsibilities regarding the LADM_COL standard:

- Coordinating the adoption and maintenance of the core model, ensuring that it preserves the shared semantics that connect the cadastre, land registry, land use planning, and other legal territorial objects (LTO).
- Defining the criteria for validation and approval of the extended and application models, ensuring their coherence with the core and their relevance to the different sectoral domains.
- Regulating the processes of versioning, updating, and reuse of the models, promoting interoperability and preventing institutional fragmentation.
- Assigning responsibilities to the entities competent over legal territorial objects (LTO), so that each institution leads the construction and evolution of the extended models linked to its mandated functions.
- Acting as a body for intersectoral consensus-building, resolving tensions among institutional actors and ensuring alignment with the public policy on spatial data and with the National Statistical System.

In this way, the ICDE is consolidated as the highest authority for the governance of the LADM_COL standard, by concentrating the capacity to define common rules, organize institutional participation, and ensure that the model’s evolution responds both to the technical requirements of the LADM standard and to the country’s regulatory and institutional conditions for land management.

4. GUIDING PRINCIPLES FOR THE IMPLEMENTATION OF THE STANDARD

The adoption of the LADM_COL standard in Colombia is guided by a set of principles that ensure its conceptual coherence and institutional viability. These principles define the

common framework that allows integrating territorial information in a context where multiple entities, competences, and regulatory frameworks converge (ICDE, 2021).

4.1 Legal Independence

The LADM_COL core model constitutes the central framework for integration of the country's territorial information, which is administered by different entities with specific institutional mandates. Under this principle, each entity acts within its competences and retains responsibility for its own data: identifying, characterizing, processing, storing, and making them available to society within the framework of its legal obligations.

The articulation among entities is achieved through the standard, without implying an overlap of institutional mandates or requiring entities to act beyond their respective legal domains.

4.2 Technological Neutrality

The LADM_COL standard is not tied to specific technologies, platforms, or software, but rather defines a conceptual framework that can be implemented in different technological environments. In Colombia, for example, the INTERLIS language has been used to model and validate data according to the standard, which demonstrates its flexibility and adaptability to the tools available within institutions. This principle allows each entity to choose the most appropriate solution according to its capabilities and needs, without compromising information interoperability.

4.3 Semantic Harmonization

One of the main contributions of the standard is the creation of a common language among entities that manage territorial information from different domains (cadastre, registry, environment, planning, among others.).

Concepts such as *party*, *right*, and *legal territorial object (LTO)* acquire a unique and shared meaning across all systems, which ensures semantic consistency, avoids duplications, and facilitates the integration and exchange of information among institutions.

4.4 Model-Oriented Approach

This principle, central to the adoption of LADM_COL, guides the construction of different models and defines how they are structured and organized hierarchically to ensure conceptual coherence and operational flexibility in land administration. The Model-Driven Architecture (MDA) approach makes it possible to address the challenges posed by the diversity of institutional actors and local contexts, while respecting legal independence within a framework of interoperability. This approach gives rise to what have been termed levels of conformance: the core model, the extended models, and the application models.

Figure 1 schematically illustrates this model-driven architecture and its three levels of conformance, showing the hierarchical relationship between the core model, the extended models, and the application models.

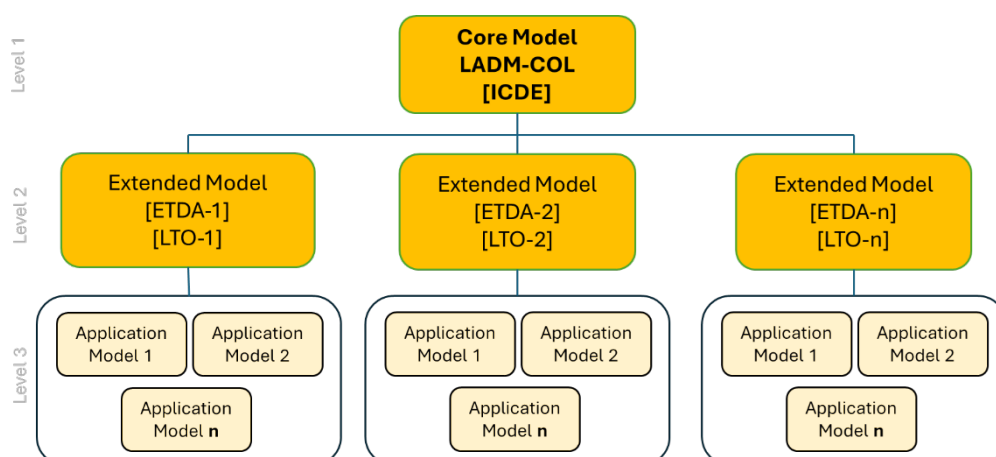


Figure 1. Model-driven architecture of LADM_COL with three levels of conformance. ETDA = Entity that Administers Territorial Data; LTO = Legal Territorial Object.

4.4.1 Core Model – First level of conformity

The LADM_COL core model establishes the ontological basis of land administration in Colombia, structuring all territorial information around the legal territorial object (LTO), which serves as the central axis. It contains the minimum necessary elements to represent the reality of the territory, common to all areas of land administration, and ensures that all involved entities share a single conceptual and semantic framework and guarantees the interoperability of the derived models. Its design is based on ISO 19152:2012, and its governance lies with the ICDE.

4.4.2 Extended Models – Second level of conformity

From the core model, different models, referred to as “extended models,” are derived. Each extended model is intended to characterize or describe a specific LTO, providing the minimum and sufficient information to represent it distinctly.

These models retain the classes of the core and may add new thematic classes according to the needs of each LTO. An extended model is considered conformant with the core if it preserves its base structure and the behavior of its classes intact. This structure ensures the specialization of information without losing consistency with the common conceptual framework. The LADM_COL Extended Models are developed and governed by each entity that manages territorial data, according to their institutional mandates and legal competences. Data interoperability takes place at this level.

4.4.3 Application Models – Third level of conformity

From the extended models, application models are designed for practical applications or specific tasks, such as information exchange between entities, support for specific processes, or the implementation of services. They may include all the classes of the extended model and add any additional ones required for technical or functional implementation. This flexibility ensures that the standard can be adapted to concrete needs, including local territorial particularities, and consolidates the third level of conformance within LADM_COL. As many

application models as necessary can be created. However, they are unique and exclusive to each extended model.

5. LEGAL TERRITORIAL OBJECT (LTO)

The Legal Territorial Object (LTO) constitutes the fundamental unit of land administration in Colombia under the LADM_COL standard. Conceptually, it is equivalent to the Basic Administrative Unit (BAUnit) defined in the international standard, but adapted to the Colombian context. It refers to each element that makes up the territory whose existence depends on legal, regulatory, or administrative provisions, and which must be managed, recognized, or regulated by a State entity, establishing a framework for the organization of territorial information (ICDE, 2022).

Before the adoption of LADM_COL, the Colombian cadastre focused on the representation of land parcels. The concept of Legal Territorial Objects (LTOs), originating from the Cadastre 2014 declaration—which defines them as “a portion of land where homogeneous conditions exist within its boundaries” (Kaufmann & Steudler, 1998)—broadened this vision to include any portion of the territory defined by rules that generate rights, restrictions, or responsibilities (RRR).

The ICDE, in collaboration with the DNP, has preliminarily identified 71 LTOs, classified into ten thematic categories: environmental, agricultural, hazard and risk, administrative areas, cadastre, land use planning, geological, infrastructure, marine–coastal, and mining–energy. Among them are national parks, forest reserve areas, mining concessions, water protection strips, and easements. All share the characteristic of being backed by specific regulations and of being managed by State entities, which gives them an institutional and legal dimension within land administration (ICDE, n.d. b).

This concept allows for an integrated view of the different objects that make up the territory, recognizing their thematic and legal diversity, while proposing a common framework of representation based on their minimum characteristics.

It is relevant to note that different LTOs may coexist in the same portion of the territory. For example, on the same land parcel, private property and an environmental protection area may overlap, each regulated by different legal provisions and managed by different entities. Each entity is limited to recording and maintaining the information corresponding to its competence, in compliance with the principle of Legal Independence. At the same time, the information generated can be integrated and made available to decision-makers at different levels of government, facilitating more effective land administration.

6. EXTENDED MODELS IMPLEMENTATION

The implementation of the extended models in Colombia, which constitute the second level of conformance within LADM_COL, has been a gradual and strategic process. Its purpose has been to adapt the international LADM standard (ISO 19152) to the specificities of the Colombian territory. This progressive effort has enabled the creation of extended models that address specific thematic needs of land administration, each linked to a particular Legal

Territorial Object (LTO) and backed by a defined regulatory framework. The main extended models generated to date are described below.

6.1 Cadastral-Registry Extended Model (MECR)

The Extended Cadastre–Registry Model (MECR) characterizes the LTO Parcel and has been jointly developed by IGAC and SNR, the highest regulatory authorities in cadastre and land registry, respectively.

The current version is 4.1, adopted through Joint Resolution IGAC 1456 and SNR 09844 of September 12, 2024, and establishes a standardized model for multipurpose cadastral management, ensuring interoperability of cadastral and registry information at the national level.

This model defines the minimum variables required to characterize all parcels in Colombia. Each parcel must be associated with land, with or without constructions, and its physical, legal (RRR), and economic components are described. Likewise, it allows the identification of the different parties (individuals, groups, companies, entities, or collectives) that hold a legal relationship (formal or informal) with each parcel.

6.2 Extended Data Model for the Cartography of Land Use Planning Instruments (LADM-POT)

The LADM_COL-POT extended model characterizes the LTO corresponding to the Territorial Land-Use Plans. This model has been developed and is governed by the Ministry of Housing, City, and Territory (MVCT), the national authority in matters of land-use planning in Colombia. The Territorial Land-Use Plans (POT, PBOT, EOT) are urban and rural planning instruments through which Colombian municipalities define land use, establish development guidelines, and set criteria for environmental and risk protection.

The current version is 2.0, adopted through Resolution 0058 of February 12, 2025, by the MVCT, and has the purpose of standardizing the geographic information used in the formulation and revision of these plans, fostering an integrated and coherent view of the territory. This model, in particular, includes a heterogeneous LTO consisting of multiple territorial objects, since the Rights, Restrictions, and Responsibilities (RRR) over land derive from various conditions defined in land-use planning instruments, such as: hazard and risk zoning, Land Classification (Urban/Rural/Expansion)—which, in the case of urban land, may be classified as protection zones and is determined by urban development treatment and activity areas—and, in the case of rural land, by its land-use category.

This model defines territorial objects, domains, attributes, and specific relationships for land-use planning management, enabling a consistent flow of information across different levels of administration.

6.3 Extended Model for Collective Property Territories (LADM_COL-TPC)

The LADM_COL-TPC extended model characterizes the LTO Collective Property Territory. This model has been developed and is governed by the National Land Agency (ANT), the national authority for the identification and establishment of collective territories of Indigenous communities (resguardos) or Afro-Colombian, Raizal, and Palenquero

communities (NARP) in Colombia. This model seeks to guarantee the interoperability and standardization of geospatial and alphanumeric information related to these territories, facilitating their integration into the Land Administration System (LAS).

The current version is 1.0, adopted through Resolution No. 202510001528976 of May 19, 2025, by the ANT, and establishes a data structure that formally represents collective rights over the territory, the collective right holders, the associated spatial units, and the source documents supporting each collective property title. In addition, the model is aligned with the principles of interoperability, technological neutrality, and modularity, facilitating its integration with cadastral, registry, and territorial management systems that incorporate a differential approach (ANT, 2025a).

6.4 Other Extended Models under Development

In addition to the previously mentioned models, other extended models being developed under the LADM_COL standard are aimed at addressing additional LTOs. These models are being designed to ensure conceptual coherence and the interoperability of territorial information. Some of them are presented below (ICDE, n.d. a):

- **Extended Model of Hydrocarbon Areas of the “Land Map”** managed by the National Hydrocarbons Agency (ANH). This model aims to standardize geospatial information related to portions of the territory where petroleum or gas resources are recognized, explored, or extracted, including deposits, concessions, and associated legal restrictions, thus facilitating their management and ensuring their integration with other territorial information systems.

- **Extended Model of Protected Areas**, managed by the National Natural Parks of Colombia. This model seeks to structure information on the country’s protected areas, enabling more efficient management consistent with current environmental regulations. Protected areas are designated geographic areas established and managed to conserve biodiversity, ecosystems, and natural resources, and may include national parks, nature reserves, and other types of conservation areas.

- **Extended Model of the Agricultural Frontier**, coordinated by the Rural Agricultural Planning Unit (UPRA). This model is oriented toward the characterization and management of agricultural frontiers, facilitating the planning and organization of land use in the agricultural sector. The agricultural frontier refers to the boundary that demarcates the areas where agricultural activities are carried out, and its identification and monitoring are essential for rural development planning and sustainable territorial management.

These models are under development and are expected, once completed, to form part of an interoperable data ecosystem under the LADM_COL standard.

7. APPLICATION MODELS

The application models, which constitute the third level of conformance within LADM_COL, make the extended models operational, translating their conceptual structure into instruments used in territorial management. Their existence provides flexibility to the LADM_COL hierarchy of conformance, by allowing each extended model to generate applications adapted to specific processes, as long as the semantics of the extended model from which they originate are preserved.

The governance of application models depends directly on the governance of the extended model from which they derive. The ICDE, as the authority over the core model, has established that each extended model is governed by the custodian entity of the thematic information of the respective LTO. Consequently, these custodian entities define the creation, use, and mandatory status of the application models within their domain.

Although **any** extended model can generate its own application models, so far only the **MECR** has done so formally, given its longer track record and the governance framework defined by IGAC and SNR under the Parcel LTO. In this context, the following models have been established:

- **Cadastral survey model**

Its first version was adopted as binding, requiring all cadastral managers in the country to use it as a reference in cadastral formation and updating processes. This mandatory nature, however, limited methodological flexibility, as it led users to employ certain methods when the regulatory framework allowed for more options, and it also limited the ability to adapt surveys to local territorial specificities. For this reason, it ceased to be mandatory and its updating was discontinued, although it remains available in the official ICDE repository as a reference point for those wishing to use it again (IGAC, 2023b).

- **Cadastral Management Transfer Model (TGC)**

It was adopted through IGAC Resolution 746 of 2024(c), and was created to govern the transfer and receipt of cadastral information—databases, technical inputs, case files, and other official records—when a territorial entity assumes or ceases the role of cadastral manager. Its existence ensures continuity and consistency in cadastral administration, avoiding gaps in information flows. It is currently under revision, as it was built on a previous version of the MECR.

- **Model for Parcels that Correspond to or Coincide with Indigenous Territories and Territorialities**

Since the adoption of the MECR and within the framework of the National Development Plan policies, the need arose to incorporate an intercultural approach to land parcel management. For this purpose, consultation processes were carried out with Indigenous peoples' organizations, in which culturally respectful technical criteria and guidelines were defined. This model, adopted through IGAC Resolution 807 of 2025(b), seeks to ensure the effective participation of Indigenous peoples in identifying the parcels that make up their territory.

- **National Cadastral Information System (SINIC)**

Although cadastral management is partially decentralized among authorized cadastral managers, IGAC, in its role as the governing body, is responsible for consolidating the country's cadastral information into a single standardized database. Within this framework, the SINIC application model, officially adopted through IGAC Resolution 301 of 2025(a), was designed as a standardized reporting scheme, ensuring that the data generated by all managers converge into a single, coherent national database. Before incorporation, the information must undergo quality control processes in compliance with technical specifications, thereby ensuring the interoperability of cadastral information and its integration with the property registry.

8. DISCUSSION: CHALLENGES & PERSPECTIVES

The transition from a fiscally oriented cadastre to a multipurpose cadastre, conceived as the basis for supporting land administration in Colombia, represented one of the greatest challenges in the implementation of the LADM_COL standard. In an initial phase, around 2018, it was thought that the scope of the cadastre should incorporate multiple additional dimensions, which explains why the first adopted model was an extended model led by IGAC, even though there was not yet an explicit core model. Although ICDE actively participated in model development from the outset, its role was later consolidated as the inter-institutional governance body of the standard in Colombia.

In the construction of the second version of the core model in 2022, the concept of the LTO was introduced as the central concept. This notion enables each entity to represent its domain-specific information under a common, standardized semantics, thereby ensuring interoperability from the very design stage. The model-driven approach with three levels of conformance thus proved to be robust, as it allows any entity managing territorial data to join the ecosystem without compromising overall coherence.

Nevertheless, the model hierarchy also poses limitations. Updates to the core model compel adjustments to the extended models, and modifications to the latter affect the application models. This generates a chain of dependencies that prolongs adaptation processes, increases costs, and at times forces the reconsideration of previously implemented schemes.

This challenge is clearly illustrated in the evolution of the MECR. As the first to be developed, it had a highly detailed design which, although it reflected the intention of capturing as much information as possible, ultimately made data collection slower, more complex, and more costly. Currently (2025), it is in its fourth version, streamlined to a set of minimum and sufficient variables, a process that required several sectoral regulatory reforms. The most recent version of the MECR (4.1), adopted in 2024, responds to the latest update of the core model of 2023 (4.0.1) to ensure conformance and long-term stability, in line with the guidelines established by ICDE and with a view to achieving interoperability within the LAS. At present, Colombia has reached a mature regulatory, conceptual, and technical platform as a result of this evolutionary process. However, the main challenge is the effective uptake by the entities responsible for territorial information. Implementing the standard requires not only incorporating new semantics to reconceptualize processes, but also having trained professionals within the institutions to address the technical complexity involved in implementing these structures into spatial databases that conform to the LADM_COL standard.

9. CONCLUSIONS

The adoption of the LADM_COL standard in Colombia has confirmed that adapting an international standard to national contexts requires broad and participatory governance, in line with previous international experiences. The transition from a historical reality in which each entity generated its own territorial data and information without standardization or interoperability, to an integrated and standardized vision of territorial information management and administration required a paradigm and mindset shift that materialized in the creation of ICDE as the coordinating authority.

The core model and the LTO concept represent conceptual milestones that ensure semantic stability and enable the progressive integration of diverse entities. The extended and application models, in turn, provide operational flexibility and adaptability to specific thematic or local domains.

Despite these strengths, the process has revealed that the hierarchical dependency between model levels introduces significant costs and update times. In the case of the MEGR, its progressive simplification through a minimum and sufficient information approach for cadastral parcels shows that the success of implementation depends as much on conceptual robustness as on the practical capacity to translate the model into efficient solutions.

In sum, Colombia now has the regulatory, institutional, and technical structure to consolidate an interoperable and sustainable Land Administration System. The immediate challenge is to accelerate the uptake of the standard by sectoral entities, overcoming resistances arising from conceptual redefinition and advancing in the technical materialization of interoperability. This constitutes the necessary condition for the LADM_COL standard to be consolidated as an effective instrument for integrated land management.

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