Land Administration Domain Model OGC Standards Working Group

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Key words: LADM, OGC, ISO, FIG, LADM implementation

SUMMARY

In February 2019 the OGC White Paper on Land Administration is published. This White Paper provides an overview of the land administration domain and relevant developments. It also proposes necessary actions for the design and development of an implementation standards. The document includes an overview of needs and requirements as earlier discussed during the various LADM Workshops.

During the closing session of the 2021 LADM/3D workshop (embedded in the FIG e-Working Week 2021) FIG expressed its commitment to collaborate with ISO and OGC regarding the implementation of LADM as an integral component of the standardisation efforts in land administration.

Currently, the LADM revision is ongoing and includes land registration, marine space geo-regulation, valuation information, spatial plan information. Further, enhanced support in cadastral surveying is proposed to be provided, through a comprehensive survey model. The new edition is multipart, part 6 is on a standard for LADM implementation. The development of this can be strategically aligned with the developments of the other parts of LADM edition II.

This paper serves as an initial step towards fostering a dialogue to promote the implementation of LADM. It emphasis the creation of a Land Administration Domain Model Standards Working Group Charter within the OGC. A draft charter is currently available for reference, along with insights from the 2019 White Paper. It is imperative to engage stakeholders from industry/business, government and academia in this development to ensure its success and relevance.

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1. INTRODUCTION

In 2012, the first edition of the Land Administration Domain Model (LADM) is approved as an official ISO standard (ISO, 2012; Lemmen et al. 2015). LADM covers the 'information-related' components of land administration (LA) by providing a shared ontology and defining common terminology for LA. The representation of all tenure types is supported through the standard and it provides a solid framework for the development of 3D Cadastre and other LA components. The standard uses the term 'land administration' in a broad sense, including geographical spaces covering water, land and elements above and below the surface of the earth.

As an ISO standard, the LADM is subject to periodic revision, typically in a 6 to 10-year period aiming to meet upcoming user requirements, extend the scope of the standard, as well as revise the current edition. In 2019 it is agreed within ISO/TC211 that the second edition of the LADM will be developed as a multi-part standard, with experts being involved from academia, industry, standardization bodies and professional organizations across the world.

Currently, the LADM revision is ongoing (Lemmen et al., 2023), and among others, the missing functions of land administration in edition I are now added in the revised edition: valuation information, spatial plan information, and marine space georegulation. Further, enhanced support in cadastral surveying is proposed to be provided, through a comprehensive survey model. New types of spatial units are proposed as well as options for implementation of the standard are proposed to be included.

The Fit-For-Purpose Land Administration approach (FIG/World Bank, 2015; UN-Habitat, 2016) argues for cost-effective, time-efficient, transparent, scalable, and participatory data collection and management, including participatory surveying, volunteered land administration, and crowdsourcing. The approach is affirmed in the Addis-Ababa Declaration 'Geospatial Information Management towards Good land Governance for the 2030 Agenda', (UN-GGIM, 2016)[1]. The approach sets requirements for future Land Administration.

In June 2016 the Land Administration Domain Working Group is established[2] in the Open Geospatial Consortium - a consortium of companies, government agencies, and universities participating in a consensus process to develop publicly available geospatial and location-based services. Within the OGC the Domain Working Groups (DWGs) provide a forum for discussion of interoperability requirements and issues, discussion and review of

[1] https://ggim.un.org/documents/Addis%20Declaration%20Final%2022Apr2016.pdf
[2] https://ggim.un.org/meetings/GGIM-committee/6th-Session/side_events/Land%20Administration%20Working%20Group%20-%20UNGGIM.pdf

implementation specifications, and presentations on key technology areas to solve interoperability issues. The Land Administration DWG outlines activities related to land administration. Worldwide, effective, and efficient land administration is an ongoing concern, inhibiting economic growth, property tenure, protected environment etc. The initial membership of the Land Administration DWG is open to both OGC members as well as experts from outside of OGC. A critical aspect of the work of the Land Administration DWG is to learn about and document the requirements from the entire community.

In February 2019 the OGC White Paper on Land Administration is published. This white paper provides an overview of the land administration domain and relevant developments and proposes actions needed for the design and development of an implementation standards in this domain. The document includes an overview of needs and requirements as discussed by an inventory through an international group of experts during the LADM Workshop in Delft, The Netherlands in March 2017 and in Zagreb, Croatia in April 2018. Some of these needs recommend an extension of LADM.

The OGC White Paper on Land Administration proposes close cooperation between the Open Geospatial Consortium (OGC) and ISO, this is expected to accelerate these developments. Due to the Covid-19 pandemic, this proposal was not discussed further until the LADM/3D Land Administration Workshop in 2021 which was embedded in the FIG e-Working Week. During the closing session of that workshop FIG agreed to look for cooperation with ISO and OGC on LADM implementation (as part of the standard). This cooperation was given substance at the VII Croatian Congress on Cadastre and at the 10th Workshop on the Land Administration Domain Model held in 2022 in Dubrovnik, Croatia and during meetings of the Land Administration Domain Working Group at the OGC.

With the development of edition 2 of LADM well underway. This paper attempts to start the discussion on taking actions to advance the LADM implementation. At this moment a preparation and planning in alignment with the developments of the other parts of LADM is possible. The objective is to create a Charter for the LADM Standards Working Group within OGC. To accomplish this, a draft charter that is readibly accessible is used, along with references to the insights that were provided in the 2019 White Paper. The active involvement of stakeholders from business, government and academic sectors is imperative. Standardisation in Land Administration finds support and recognition in the Framework for Effective Land Administration of the United Nations Committee of Experts on Global Geospatial Information Management, UN-GGIM (2020).

In this paper chapter 2 offers a review of the current progress and planning related to the development of LADM edition II. Subsequently, chapter 3 presents a comprehensive background and context of ongoing developments, which serves as a basis for establishing the needs and requirements for land administration: Data acquisition, maintenance and dissemination. Chapter 3 revisit and summarises the insights from the OGC Land Administration White Paper. Following this, Chapter 4 discusses consideration and actions aimed at advancing the implementation of LADM. This is in line with the development of the OGC charter for the Standards Working Group on Land Administration. The paper ends with a series of recommendations outlined in Chapter 6.

2. STATUS OF LADM DEVELOPMENT

This chapter focuses on the structure of the second edition of the ISO 19152 LADM and its proposed operational capabilities, through the new parts that are currently under development. Six parts are currently under development, each part follows the ISO standardization process and is in fact a standard in itself. The parts of the second edition of the LADM are the following:

- Part 1 – Generic Conceptual Model
- Part 2 – Land Registration
- Part 3 – Marine Space Georegulation
- Part 4 – Valuation Information
- Part 5 – Spatial Plan Information
- Part 6 – Implementation Aspects

During the revision process, close collaboration with various FIG Commissions is being achieved, specifically, FIG Commissions 3 'Spatial Information Management' and 7 'Cadastre and Land Management' for part 2, Commission 8 'Spatial Planning and Development' for part 5 and Commission 9 'Valuation and the Management of Real Estate' for part 4.

Figure 1 presents the five out of six parts that are currently under development. The development of part 6 has not yet started. As noticed from the standards' titles, a new term "georegulation", with a wider meaning. The concept of georegulation is introduced, encompassing the delineation of geographical spaces in 2D, 3D, or 4D dimensions. This term is particularly relevant when referring to marine environments. As mentioned, standards should include a set of requirements that form the basis of the scope, and which are further used to specify an abstract test suite. The packages structure of the new edition is designed in a way that meets the requirements that have been developed during the revision process, see (Lemmen et al., 2023).

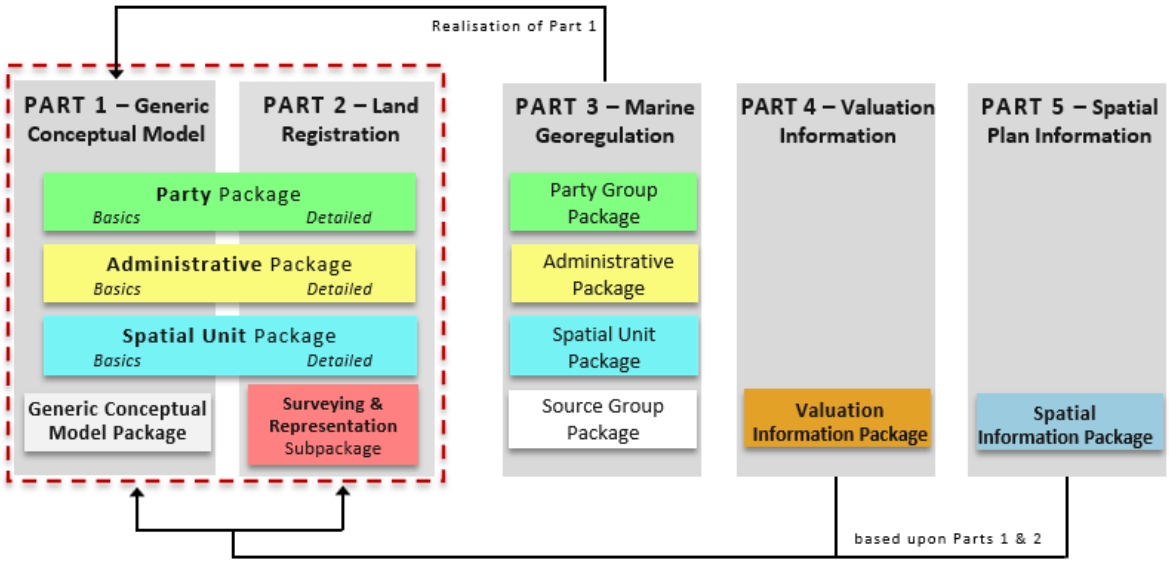

Figure 1. Parts 1, 2, 3, 4 and 5 of LADM Edition II that are currently under development

Part 1 is a high-level umbrella standard that supports all the other parts of the new edition of the LADM and provides an overview of all parts. The “Party”, “Administrative” and “SpatialUnit” packages are common packages in part 1, as well as, in part 2. For the common packages, in part 1 the fundamental notions are introduced, while the detailed description of these packages is included in part 2 (attributes, multiplicities of relationships and attributes). It is noted that part 1 will not only be backwards compatible with the previous version of the LADM but also with the IHO S-121 ’Maritime Limits and Boundaries’ standard (Beaupré et al., 2022; IHO, 2016) that will be used as basis for part 3.

Part 2 focuses on Land Registration and will be largely based on the first edition of LADM, with refinement and extension at the survey model, the 3D spatial profiles and semantically enriched code lists. Part 3 on Marine Georegulation harmonizes the description of Rights, Restrictions and Responsibilities in the marine domain, aligned with land concepts to provide seamless land/ marine LA.

Moreover, parts 4 and 5 have each been designed as a single package, both based on the definitions in part 1 and part 2. In part 4 the Valuation Information Package is introduced concerning valuation information used and produced in the context of LA, specifying the characteristics and semantics of valuation registries maintained by public authorities. In part 5 the Spatial Plan Information Package deals with spatial planning information and includes the planned land use (zoning).

Lastly, part 6 concerns the implementation of the standard. It is planned to propose a methodology for developing a LADM-based country profile, an abstract framework for representing LA workflows (processes), a metamodel for structuring and managing semantically enriched code list values, as well as support different encodings. In addition, Part 6 is expected to include the OGC API family of standards-compliant recommendations for the development of interoperable LADM schema-based information systems. Furthermore, the relationships between the LADM and the instruction guidelines for property measurement, such as the International Property Measurement Standards (IPMSC, 2023) and the International Land Measurement Standard (ILMSC, 2019), is planned to be included in part 6. Part 6, ‘Implementation’ is planned to be developed in cooperation between OGC, ISO TC 211 and FIG. The project for part 6 could start in February 2026 if Part 5 is to finish in late 2025. Encoding of Part 5 elements could be done in parallel with its approval.

The development of the various parts is executed in parallel, but the revision and voting procedures take place independently. Figure 2 shows the status (September 2023) of all parts of the second edition, while the expected publication year is presented below:

- 19152-1: October 2023
- 19152-2: January 2025
- 19152-3: March 2024
- 19152-4: June 2025
- 19152-5: September 2025
- 19152-6: depends on start within OGC (Standards Working Group)

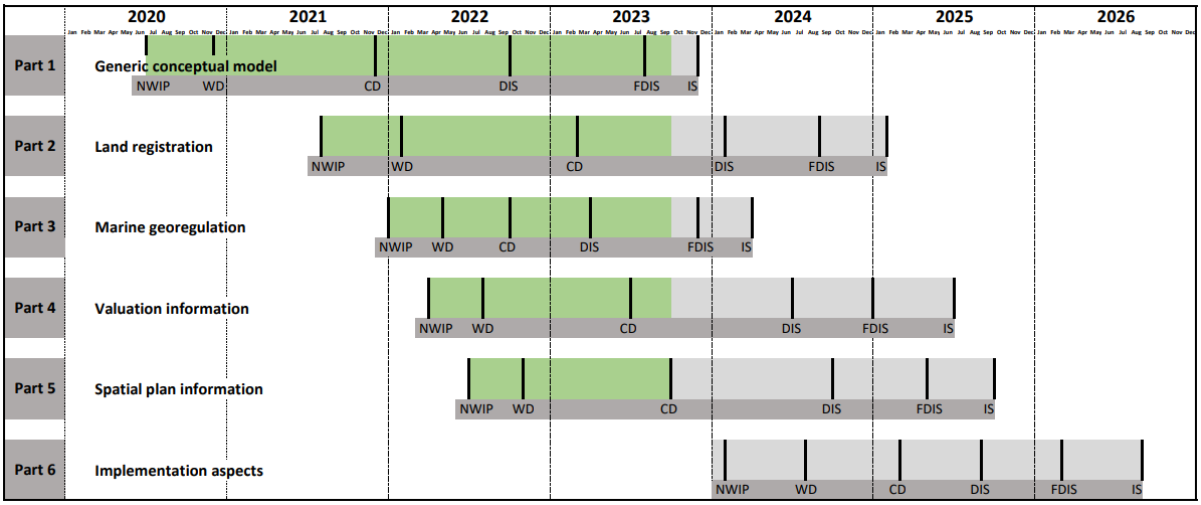

Figure 2. Planning of the development of the different parts of the second edition of LADM (NWIP = New Working Item Proposal, WD = Working Draft, CD = Committee Draft, DIS = Draft International Standard, FDIS = Final Draft International Standard, IS = International Standard). September 2023.

3. OGC WHITE PAPER ON LAND ADMINISTRATION

This chapter provides an overview and contextual background of ongoing developments. It serves as a basis for analyses and definition of requirements and needs association with data acquisition, maintenance, and dissemination of data. Requirements range from the development of 3D cadastre (including underground utilities and infrastructure) to the initial set up of a land administration or initial data collection. Initial data collection may concern creating an overview of all people to land relationships in a certain area. Data maintenance is crucial: people-to-land relationships are dynamic. Certain aspects of interoperability are explored concerning the establishment of Public Private Partnerships (PPPs). PPPs can be organized within a technical context as web services, portals and/or data exchange mechanisms.

3.1 Data collection

Comprehensive Recording of legal status:

Ongoing urbanization and development of infrastructures require a proper recording and registration of the legal status which can only be provided to a limited extent by 2D cadastral systems. 3D, including indoor modeling, is required to capture the whole legal and spatial dimension, which includes the marine environment.

Different Approaches based on land value:

In cases where value of land is higher or an intensive level of land use exists, conventional field surveys using high-precision instruments (GPS, Total Stations, Laser scans) can be deployed as usual. Areas with lower value may require other approaches (use of imagery, lidar, radar). By following the Fit-For-Purpose approach, Land Administration is simple at the start and can improve over time whenever necessary. It is a dynamic process: it is adapted to different countries/territories, applied technologies and administrative approaches. The approach must be gender sensitive, transparent, and highly participatory.

Key Role of Metadata and LADM:
Implementation of the Fit-For-Purpose Land Administration approach requires a good model for data description using metadata, as incorporated in LADM. LADM supports the continuum of land rights and a continuum of approaches in data acquisition and recordation and many different representations of spatial units (point-based, line-based, polygon-based, and volume-based), and parties (from groups to individual and non-natural persons). Different types of survey approaches must be accommodated to allow integration of new cadastral data with existing data, and to assure retention of original field observations. In all cases there should be options to include rights and right holders with attributes. Adjustments of field observations to existing cadastral spatial data is performed in the field or in cadastral GIS posteriori. Additional surveys are also used in support to quality improvement of cadastral data.

Cloud Based Data:
Modern technology, including mobile apps and cloud based platforms, streamlines field data exchange to a cloud-based GIS environment, enabling remote access and observation. Field surveys provide a comprehensive overview of all existing land relationships, including overlapping claims.

Automated Feature Extraction and Future Prospects:
Automated feature extraction may be applied to boundaries of plots bounded by topographic features. If extracted features are visualized on printed or screen-displayed imagery, they can be used to identify features that are identical to cadastral boundaries. Feature extraction may be helpful in estimating the number of parcels that can be expected in project areas. Further progress and improvements with automated feature extraction is anticipated in the years ahead.

Challenges in Data Acquisition:
Data acquisition for a vast amount of spatial units is an enormous operation. Numerous polygons, lines and points are to be surveyed (or in a central place in the village) and need to be linked to formal and informal holders of real rights and/or use rights. The organization of this process requires enormous amounts of human-supported activities related to logistics and case management – which can be linked to geographic information.

3.2 Processes, maintenance and transactions
Cadastral Map Updating and Data Management: Cadastral map updating includes adjustments and transformations of field observations (collected at different moments in time and with different survey instruments or via use of imagery from different sources) to the spatial database. Implementation of tolerances to manage the differences in measurements should be flexible and purpose related. Results of subdivisions of spatial units and the results of land readjustments and land consolidation may need to be shared with other systems.

Interconnection with Other Systems:
Management of areas is needed: there may be more than one area to be maintained for the same spatial unit and the legal and accurate area as calculated in the cadastral GIS may not match other records.

Data Layers and Quality Enhancement:
Conversion of social tenure to legal tenure is a process that may require different levels (layers) of data with related attributes. The same is valid for geometric quality improvements of the cadastral map.

Electronic Signatures and Data Provision:
Processes can be organized based on the use of electronic signatures in cases of applications and information requests requiring public or private keys and encryption/decryption.
Provision of information to data collectors for initial data collection or maintenance is a specific but very important process (task management, logistics). This provision of data can be paper-based imagery or digital. Data provisioned in participatory approaches include: roles, ids, photos, signatures, fingerprints, video, voice recording, right types, restrictions, and disputes.

VGI and Crowdsourcing for Land Administration:
VGI and crowdsourcing for Land Administration where rightsholders and communities collect and maintain their own data with a certain level of professional support for quality assurance, etc.

Integration for Comprehensive Land and Property Rights:
To ensure securing land and property rights for all, there needs to be concerted efforts to improve the production of data and the generation of information needed to record all forms of people-to-land relationships that will provide effective and efficient Land Administration Systems. There will be a need for considerably more integration across the various national data and information systems and platforms in order to leverage the most effective data and analysis for evidence-based policy formulation and decision making.

Transactions and Standardization:
Updates, changes and deletions may concern (attributes related to) parties, RRRs, basic administrative units and spatial units. Common transactions are buying and selling, establishment of (a) right(s), (e.g. encumbrance, usufruct, or tenancy) and the inclusion of the result of spatial planning, e.g., land consolidation or land readjustment. More generic process-related modules (Stubkjaer, et al., 2007) in data acquisition and data handling as well as maintenance and publication are needed. Standardization can make it easier to monitor the progress of global indicators. LADM has roles included as well a series of dates in processes – but LADM Edition I does not include yet processes for initial data acquisition, data maintenance, and data publication. Cadastral data maintenance can be 'systematic' or 'sporadic.' Transactions require source documents providing the basis for changing and updating the data in the database – from one consistent state to another. Attributes in all classes can be subject to change.

Blockchain and Smart Contracts:
The blockchain is a secure mechanism to handle and store transactions in a distributed ledger. Once a transaction has taken place, it cannot be altered or erased from existence and a transaction is irreversible. Not only the transaction itself, but also the history of transactions, is safely captured, making the data immutable and hence providing trust. Blockchain is known

as the ‘distributed ledger;’ it is the database that provides proof of who owns what at any given time and it is publicly available and publicly maintained. Smart contracts are contracts whose terms are recorded in a computer language instead of legal language. Smart contracts can be automatically executed by a computing system,

Geometric Accuracy and Quality Labels:
Geometric accuracy can be represented with quality labels identifying the relative and absolute accuracy of geometric data. This is relevant for adjustments to existing coordinates later on during maintenance and for the integration of data from different sources collected with different instruments and tools in different survey approaches. Accuracy is also about ‘linking’ polygons and people. That means the quality of the links between spatial units (in cadastre) with rights (in the registry) and rightholders (basically in population register or business register).

Required Functionalities and Data Collection:
Required functionalities should be deployable on a single device, i.e., functionalities for using image-based data acquisition combined with collection of coordinates with handheld GPS, biometric data (fingerprint identification and facial recognition), and voice/video recording in support of object identification. Devices supporting these functions could also be useful for inspections, for fieldwork related to building and construction permits, for cadastral maintenance, etc. Land data collected on many devices should deliver results in formats based on operational standards.

Legacy Data and Digital Archiving:
Legacy data may be located and stored all over a country in administrative (legal) and spatial (survey) archives. The paper documents in those archives often have a legal meaning. After digitizing the documents, they are not yet archived in a unified manner compliant with (international) standards: this applies to both the archives with the maps as well as the archives with the deeds. Having a digital archive is one of the preconditions for e-services to function optimally. Stages of digital archiving may be distinguished: protection of the existing archives; scanning and indexation; quality improvement of the archives; optimization of internal consistency; and integration of the digital archive in workflows.

3.3 Interoperability and Outputs

The development of effective land administration systems necessitates a robust structure of interoperability, data sharing, and data integration. This structure extends to external databases, including those containing information on addresses, population registers, businesses, buildings, utilities, and more. Access to these databases is crucial for bolstering the information infrastructure, with a particular focus on the following key areas:

Imagery and Remote Sensing Technologies:
The integration of libraries featuring cloud-free imagery compositions, generated on a large scale through remote sensing technologies, is indispensable. This integration includes approaches to initial data acquisition, methods for public review and inspection, and comprehensive coverage checks.

Data Sharing and Avoiding Duplication: Data sharing principles play a pivotal role, allowing data to be collected once and utilized multiple times by establishing linkages with Spatial Data Infrastructures (SDIs). This approach helps prevent redundant data collection and maintenance while ensuring that data remains 'kept at the source.'

Internet-Connected and Disconnected Environments:
Services must be adaptable to both internet-connected and disconnected environments, recognizing that internet reliability can be variable across different regions. This adaptability supports online declarations of land rights by property holders while maintaining quality assurance procedures.

Diverse Applications:
The potential applications of land administration services are multifaceted. These encompass reporting land disputes and conflicts, handling requests for information, publishing land data, delivering products and services, formalizing land rights, renovating maps, enhancing quality, and digital archiving.

Fiscal Registries:
Fiscal registries or databases serve as repositories for a comprehensive array of property unit characteristics, encompassing legal, physical, geometric, economic, and environmental aspects. These registries play a pivotal role in property valuation and taxation.

Interconnection with Public Registries:
A robust land administration infrastructure is imperative to establish linkages between fiscal registries and other public registries, including cadastres, land registries, building and addresses registries etc. This interconnection facilitates the generation of titles, certificates, spatial data, legal and administrative information, statistical data, and more.

A well-integrated and interoperable land administration system necessitates seamless access to external databases, robust data sharing mechanisms, adaptability to varied connectivity scenarios, and a wide array of applications to meet the evolving needs of land management and administration.

4. CONSIDERATIONS & ACTIONS TO ADVANCE LADM IMPLEMENTATION

This chapter provides some considerations and possible actions that could be relevant to the further development of the Land Administration Charter for a Standards Working Group at the OGC. With the ongoing developments a new OGC Standards Working Group (SWG) is planned to be formed, it is expected that OGC members propose a OGC Land Administration Domain Model LADM SWG. The SWG name, statement of purpose, scope, list of deliverables, audience, and language specified in the proposal will constitute the SWG's official charter. This charter will be prepared by OGC, but considerations and actions to advance LADM implementation are welcome and can be forwarded by DWG members.

Decision making on participation in the SWG is beyond the scope of this paper. It does, however, suggest consideration of the "digital gap." There are countries with a development edge that have the knowledge and capacity to participate. For other countries it is more difficult. Representation of those countries could be through GLTN, FIG, ELRA/CINDER. Or perhaps through some other approach. Organisation of participation/representation of countries in Africa could be an issue for discussion during the “First High-Level Forum Meeting of Presidents of Land Professional Associations in Africa” to be held in Addis Ababa in November 2023 and similar events in other continents.

Overall land administration (developing, modernizing, updating etc.) is a complex task due to the need to accommodate diverse regulatory and policy context. Interoperability between underlying technologies and systems is key in providing the necessary flexibility. There is an impetus to guide developing nations in a programmatic way to establish cost-effective, interoperable land administration, to upgrade current manual processes, and to field automated solutions that can be flexibly adapted to new data sources and new technologies.

The OGC White Paper from 2019 provides an overview of needs and requirements discussed by an inventory by an international group of experts during the LADM Workshop in Delft, The Netherlands in March 2017 and in Zagreb, Croatia in April 2018. Considered in this way, a series of requirements and proposals from the 2019 White Paper have now been developed (or are being developed) at ISO/TC211. It may be considered to discuss if a new version of the White Paper is needed, with inclusion of the Social Tenure Domain Model (ISO, 2012; FIG, 2010).

The LADM Development team is aware of approximately 50 country profiles and 10 country implementations and 17 STDM (Social Tenure Domain Model, a LADM specialization) implementations. The STDM implementations are mainly in developing countries with support of the UN-Habitat Global Land Tool Network (GLTN)). There is attention from the geospatial software and consulting industry. This interest has been discussed in the Land Administration Domain Working Group (DWG) and during various LADM Workshops.

This interest in the use of LADM drives the need to develop an encoding Standard to assist the implementing community. Currently, countries implementing LADM have to develop all the steps and technical encodings before arriving at an operational system. This is because ISO 19152 is a conceptual model, specific LADM implementation standards are missing. Since this is done by every country individually (except form STDM implementations) there are many different solutions, which is reducing the actual overall aim to support interoperability. This also increases implementation cost when adapting LADM. For industry partners (OGC members) an encoding standard would enlarge the possibility to reuse their LADM software in multiple countries (jurisdictions). All these aspects are proposed to be addressed by the proposed LADM implementation standard.

In all cases, the SWG Charter provides a basic timeline plan for their activities. The initial scope of the SWG LADM is suggested to develop:

- a methodology to develop LADM country profiles. Kalogianni (2021) introduces methodological steps for the development of country profiles, it is expected that her approach could be included in part 6;
- management/maintenance rules for semantically rich code list values (SKOS);
- a metamodel for structuring and managing semantically enriched code list values;
- a encoding Standard of the five parts of the ISO LADM Standard (currently under development). The content of the encoding Standard will derive requirements from conceptual model items in the source LADM Parts and from (a new version of) the White Paper. One or more encoding formats will be considered, referencing international Standards such as Geography Markup Language (GML), GeoJSON, Features and Geometries JSON (JSON-FG), and/or the OGC API family of standards-compliant recommendations for the development of interoperable LADM schema-based information system;
- workflows/procedures of the most important LA processes;
- instruction guidelines for property measurement, such as the International Property Measurement Standards (IPMS) and the International Land Measurement Standard (ILMS), (IPMSC, 2023; ILMSC, 2019); and:
- (optional) blockchain/ledger technology-based implementation guide. This may be in cooperation with ISO TC 307 on blockchain technologies and distributed ledger technologies.

5. CONCLUSIONS AND RECOMMENDATIONS

There is a clear challenge for the global land community and for the global geospatial community: secure land rights for all people, in all places, at all times. The biggest challenge is to keep the information on land rights up to date and accessible at the appropriate level of accuracy. In 2012, the Land Administration Domain Model (LADM) was established as an official ISO standard, a significant milestone in land administration. LADM serves as a comprehensive framework for the information-related aspects of land administration, offering a shared terminology. Importantly, it accommodates all types of land tenure and provides a robust foundation for various land administration components, including 3D Cadastre and marine spatial data.

The ongoing revision of LADM, currently underway, seeks to enhance its capabilities and address previously unmet requirements. These additions include valuation information, spatial planning data, and marine georegulation, further solidifying its relevance in the evolving land administration landscape. Additionally, it emphasizes the importance of metadata and LADM in implementing the Fit-For-Purpose Land Administration approach, which emphasizes cost-effective, transparent, and participatory data collection and management.

The overall recommendations can be summarized as follows:

- A Charter for the LADM Standards Working Group within OGC should be created to facilitate the development and implementation of LADM. This Charter should involve stakeholders from various sectors, including business, government, and academia. To ensure equitable participation, strategies should be developed to engage countries with

varying levels of development and technological capacity. Representation through organizations like GLTN, FIG, ELRA/CINDER, or other similar bodies can be explored. Emphasize on the the importance of interoperability, data sharing, and integration across land administration systems and external databases is needed. This will facilitate comprehensive land and property rights recording and support a wide range of applications, including land dispute resolution, data publication, and property valuation. A critical next step is an encoding standard for LADM to assist implementing countries and organizations. This standard should encompass methodologies for developing LADM country profiles, management rules for semantically rich code list values, and metamodels for structured code list values. It should also establish encoding formats that promote interoperability.

- The functionality and options for use of LADM should be better known and communicated. LADM is a flexible standard that can meet local requirements. It is not a prescriptive standard – it is descriptive. LADM can also be described as a land administration expert language. It describes the common denominator in land administration worldwide.
- Standards like the LADM are crucial to jump-start new initiatives and are connecting top-down and bottom-up projects. It is very important that there is awareness of this at policy level. Policies should support the implementation of standards particularly when such standards are globally agreed.
- Internationally agreed-upon and open standards will be key to unlock the value of data and the wealth of information needed to recognize all forms of people-to-land relationships, which is vital for the well-being of all humanity and sustainable development.
- It is recommended to look for options to use the OGC Innovation Initiative as one of the tools to develop LADM part 6. Business, government and academic stakeholders need to be involved.
- These recommendations reflect critical steps needed to advance the implementation of LADM and promote effective, efficient and equitable land administration practices worldwide. Collaboration among key stakeholder and ongoing reviews of these recommendations are essential to address evolving challenges and opportunities.

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