Initiating the development of a LADM II-based Country Profile for the Swedish Real Property Register RRRs

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Key words: country profile, LADM, LADM Edition II, land administration system, Sweden real property register

SUMMARY

The Swedish real property register, administered primarily by the Swedish Mapping, Cadastral and Land Registration Authority (Lantmäteriet), has a long history of providing reliable and comprehensive land records. There is a growing need for improved interoperability and data sharing among different stakeholders, integration of 3D spatial data, and addressing the legal and institutional barriers to further digitization. The Land Administration Domain Model (LADM) provides a standardised framework for modelling land administration systems worldwide, defined and developed as an international standard ISO 19152:2012 (ISO, 2012). Given the promising research of LADM-based country profiles by academics and authorities in other countries, we start developing a Swedish LADM-based country profile.

The main purpose of this paper is to initiate the development of a Swedish LADM II-based country profile for a part of the content of the Real Property Register. This study will use the three-phase methodology that has been presented by Kalogianni et al. (2021), and then focus on the Phase I to analyse current Swedish land administration and its RRRs. As the initiation step, this paper will not implement a full LADM II-based Swedish country profile, mainly focusing on the administrative aspects.

The paper presents the research methodology to initiate the development of a Swedish LADM II-based country profile, and then introduces the Swedish real property register and its content, focusing on registered RRRs. The Swedish LADM model presented in this paper is only illustrative and discusses the complexity of Swedish RRRs as an early step in producing a national Swedish model, since the legal basis for the future content and structure of the register is yet unsure. For the future work, the core LADM classes will be customized to reflect the specific requirements of the Swedish context, and relationships and associations between the classes will be established to accurately represent the interactions and dependencies within the Swedish land administration system.

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1. INTRODUCTION

The efficient management of land and property rights is fundamental to economic development, environmental sustainability, and social stability. In Sweden, the land administration framework is advanced and centralised, ensuring a high degree of accuracy, transparency, and accessibility in land-related information. The Swedish real property register, administered primarily by the Swedish Mapping, Cadastral and Land Registration Authority (Lantmäteriet), has a long history of providing reliable and comprehensive land records. This system is underpinned by robust legal frameworks such as the Swedish Land Code (Jordabalken) and integrates cadastral and registry functions to support various administrative and economic activities. This code governs the regulations related to land ownership, leases, easements, and other property rights, ensuring that legal and administrative processes are clearly defined and consistently applied. Over the years, Sweden has made significant progress in digitising land records and improving public access to land information through online platforms and services. However, the increasing complexity of land management, driven by factors such as urbanisation, sustainable development goals, and technological innovations, poses new challenges for the existing framework. There is a growing need for improved interoperability and data sharing among different stakeholders, integration of 3D spatial data, and addressing the legal and institutional barriers to further digitization, see e.g. Larsson et al. (2023) and Seipel et al. (2020).

The Land Administration Domain Model (LADM) provides a standardised framework for modelling land administration systems worldwide, defined and developed as an international standard ISO 19152:2012 (ISO, 2012). The LADM framework includes core classes such as parties, rights, restrictions, spatial units, and administrative units, which can be tailored to reflect the specific requirements of a country's land administration system. Additionally, the increasing focus on 3D representations in land administration is evident across various stages of spatial development, including planning, design, permitting, construction, enforcement, and more (van Oosterom et al., 2020). In this context, according to the statistics from research made by Kalogianni et al. (2021), LADM-based country profiles have been reported and/or developed by 40 countries, for example the Netherlands, Malaysia, Greece, Croatia, Portugal, Scotland, Serbia, Czech republic, Korea and Turkey. Given the promising research of LADM-based country profiles by academics and authorities in other countries, we start developing a Swedish LADM-based country profile.

The LADM Edition II is the ongoing revision of the LADM Edition I that aims to refine the existing content and to extend the scope of Edition I (Lemmen et al., 2021). The LADM Edition II is a multi-part standard that includes six parts: Part 1 – Generic conceptual model, Part 2 – Land registration, Part 3 – Marine georegulation, Part 4 – Valuation information, Part 5 – Spatial plan information and Part 6 – Implementation aspects. Compared with LADM Edition I, the design and development of LADM Edition II is more comprehensive as it is

based on the inclusion of rights, restrictions and responsibilities (RRRs) concerning marine georegulation, valuation information, spatial plan information as well as LADM implementation (Kara et al., 2024). Moreover, as stated in Kara et al. (2024), any country profile established using the elements defined in conformance with ISO 19152:2012 shall remain conformant with the LADM Edition II standard. By developing a LADM II-based country profile, tailored specifically to Sweden's real property register, it will be an opportunity to apply a standardised description of the system, beneficial for transparency and management of the system.
To achieve that, the main purpose of this paper is to initiate the development of a Swedish LADM II-based country profile for a part of the content of the Real Property Register. This tailored profile will facilitate data sharing, improve decision-making processes, and support the integration of new technologies into the land administration system. Therefore, this study will learn the lessons from the developed LADM-based country profiles that were modelled in accordance with the LADM Edition I, as well as the three-phase methodology that has been presented by Kalogianni et al. (2021), and then focus on Phase I to analyse current Swedish land administration and its RRRs. As the initiation step, this paper will not implement a full LADM II-based Swedish country profile, mainly focusing on the administrative aspects.
The rest of the paper is structured as follows. Section 2 describes the background of LADM Edition I and LADM Edition II briefly, and related work of the methodology for the development of LADM-based country profiles. Section 3 presents the research methodology to initiate the development of the Swedish LADM II-based country profile, and then introduces the Swedish real property register and its content, focusing on registered RRRs. Finally, Section 4 provides discussions and conclusions.

2. RELATED WORK

2.1 LADM Edition I and LADM Edition II

The LADM Edition I, formalised as ISO 19152:2012, was developed to provide a standardised framework for modelling land administration systems globally. This edition introduces a structured approach to represent land-related information and the relationships between people, land, and rights, which are fundamental to effective land administration, promoting interoperability and consistency across different jurisdictions (Lemmen et al., 2015). The LADM Edition I defines specific attributes for each core class. For example, LA_Party includes attributes like Party ID, name, and type, while LA_SpatialUnit encompasses geometric representations (2D and 3D), area, volume, and other spatial characteristics. The model also establishes relationships between these classes, such as the association between a party and their rights over a spatial unit, or the link between a spatial unit and its corresponding cadastral survey documents.
The LADM Edition II builds upon the foundation laid by the Edition I, incorporating feedback from implementations and addressing the evolving needs of land administration. Kara et al. (2024) have clearly introduced the design of the LADM Edition II with detailed collected requirements and package structures. Compared with the LADM Edition I, the LADM Edition II emphasises interoperability and data integration, supporting the seamless exchange of information between different land administration systems (Lemmen et al.,

2021). This is particularly important for addressing cross-border land issues and facilitating international cooperation.
Both the LADM Edition I and the Edition II provide robust frameworks for modelling land administration, while the Edition II is offering enhanced features and greater flexibility to address complex challenges. Figure 1 shows that the basic classes of the LADM Edition II are the same as in Edition I: LA_Party, LA_RRR, LA_BAUnit, and LA_SpatialUnit.

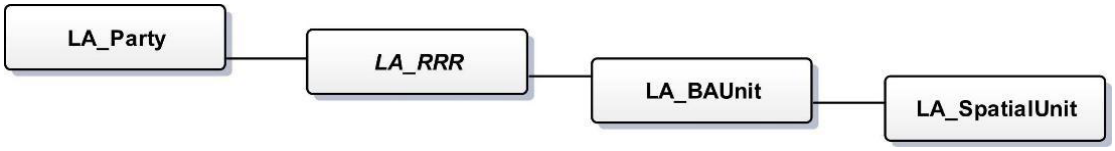

Figure 1. Generic conceptual model - basic classes of the LADM without LA_Source and VersionedObject, same basic classes as in Edition I (ISO 19152:2012; Kara et al., 2024)

In addition, the Part 1 generic conceptual model of Edition II includes two more basic classes: VersionedObject and LA_Source, as shown in Figure 2. The VersionedObject class is an abstract class that provides inheriting classes with optional attributes for indicating the beginning and end of lifespan, as well as optional real-world timestamps (Kara et al., 2024). One improvement is that the cardinality of the beginLifeSpanVersion was changed from mandatory (1) to optional (0.1), and value type for this characteristic was defined as 'real_world_time'; and another improvement is that with the associations between VersionedObject and LA_Source, instances of sources can now be versioned.

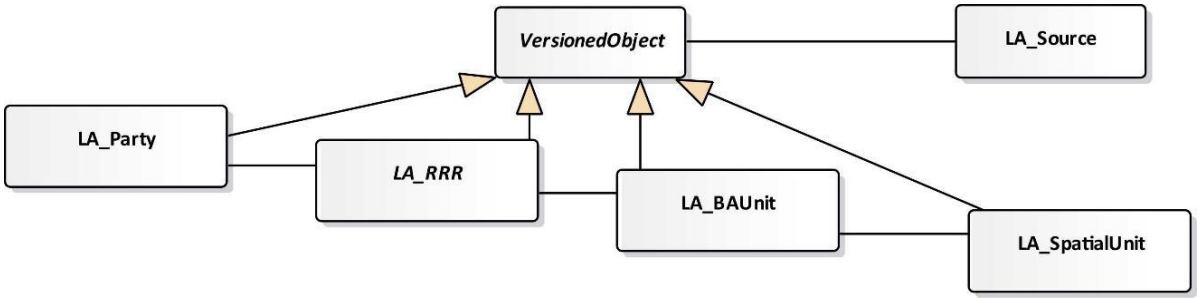

Figure 2. Basic classes of the core LADM, all inheriting from VersionedObject and associated to LA_Source (Kara et al., 2024)

As introduced by Thompson and van Oosterom (2021), VersionedObject and LA_Source have a second set of optional temporal attributes (beginValidLifespanVersion, endValidLifespanVersion, and acceptance), representing to the corresponding valid times in the real world. Which means, it could be used as version management to update, manage and maintain both spatial (2D and 3D), legal data and matching the relevant real-world valid times (4D) in land administration. In other words, this makes it easier and clearer to track the evolution of the model with a real and clear history of what changes were made, by whom, when and why. On the legal side, it will enable compliance with standards and regulations by providing a clear record of changes and updates. Meantime, for further data interoperability, it will help maintain a consistent version of the model across different implementations and stakeholders, reducing discrepancies and inconsistencies.
As introduced above, those improvements of LADM Edition II are the main reasons to initiate a Swedish LADM-II based country profile.

2.2 LADM-based country profiles

Many LADM-based country profiles have been developed and published/presented focusing on various aspects. For example conceptual models, extensions, implementation and 3D visualization (Bydłosz, 2015; Janečka and Souček, 2017; Radulović et al., 2017; Alkan and Polat, 2017; Kim and Heo, 2017; Kalantari and Kalogianni, 2018; Kebede et al., 2018; Yan et al., 2019; Indrajit et al., 2020; Kara et al., 2019).

According to related work, Kalogianni et al. (2021) summarized good practices in country profile development and proposed a three-phase approach on developing a LADM country profile in three phases: Phase I – Scope definition, Phase II – Profile creation (modelling), and Phase III – Profile testing (implementation). This methodology is expected to become part of LADM Edition II. Phase I was designed to define the scope that concerns stakeholders, current and/or future situation, national land administration legislative framework and regulations, RRRs and strategies. The authors fully agreed that the status of the LAS and its description are the fundamentals for developing the LADM-based country profile. Research for example, Buuveibaatar et al. (2022), was based on the three implementation stages for the land administration development perspective of Mongolia "Vision 2050", where each phase has specific purposes, particular goals and action plans. Thus in this paper we focus on the Phase I to analyse current Swedish land administration and its RRRs. Additionally, Ahsan et al. (2024), based on the Kalogianni et al. (2021) three-phase approach, employed a design science research approach to create a Pakistan LADM-based country profile.

3. CONCEPTUAL MODELLING

The aim of the paper is to initiate the development of a Swedish LADM II-based country profile for a part of the content of the Real Property Register. To address the challenges described, according to the methodology that Kalogianni et al. (2021) proposed, the study focuses on the Phase I to analyze current Swedish land administration and its RRRs. The research methodology is shown in Figure 3, more details presented in the following sections.

Figure 3. Research methodology to develop the Swedish LADM II-based country profile

As the initiation step, this paper will not implement a full LADM II-based Swedish country profile, mainly focusing on the administrative aspects.

3.1 Scope of the model

The primary challenges in the current Swedish land administration system include managing data interoperability, ensuring the accuracy and completeness of spatial data, and integrating new technologies such as 3D cadastres and blockchain. Legal and institutional barriers also pose significant challenges, complicating the harmonization of data and the digital transformation of land records. Additionally, issues related to data privacy and security need

to be addressed to maintain public trust and compliance with regulatory standards. The introduction of the LADM Edition II builds upon the original framework, incorporating additional classes and refining existing ones to better capture the complexities of modern land administration.
Therefore, the entire scope of the Swedish LADM-II based country profile is to describe both the current situation and the future situation that will evolve with the development of the LADM Edition II packages to further develop spatial plan, marine cadastre, valuation model, and underground cadastre. In this paper, we will only focus on the RRRs of the current Swedish Real Property Register.

3.2 Current Swedish Real Property Register

The Real Property Register is Sweden's official registry of how the land in Sweden is divided and who owns what, containing information on addresses, buildings and property tax assessment. Specifically, the Swedish cadastre serves as a foundational element for land registration, property taxation, urban planning, and infrastructure development that includes detailed records of parcels, property boundaries and cadastral surveys, while the registry maintains records of property ownership, rights, restrictions, and other legal interests in land. Together, these systems support various administrative functions, including property transfers, mortgage registration, and land dispute resolution.
The register is divided into several sections (SFS, 2000a; SFS, 2000b). The sections are: 1. general section, 2. land register section, 3. address section, 4. buildings section and 5. tax assessment data section.
A governmental committee report (SOU, 2024) published earlier this year recommends, among other things, a revision of the Swedish Real Property Register. A result of this is that the Swedish government is currently proposing to modernize the existing Real Property Register legislation, replacing it with two new laws, initially named Real Property Data Act and Real Property Register and Electronic Provision Act, planned to be implemented July 1st 2026.
The classification in this paper is based on the RRRs registered in the Real Property Register and described in the Real Property Registration Ordinance (SFS, 2000b). Other RRRs outside the register exist, but they are omitted from this initial version of the Swedish LADM profile. This study focuses on RRRs and does not aim at modelling the entire content of the Real Property Register database, which today is divided into different parts, see Section 3.3 below.

3.3 RRRs

The right to own real property is conceptually part of the family of RRR and can be said to be the central information stored in the Real Property Register. The central provisions regarding ownership and use of land are the Land Code (SFS, 1970a) and the Real Property Formation Act (SFS, 1970b). Other provisions are e.g. the Utility Easements Act (SFS, 1973a), the Joint Property Units [Management] Act (SFS, 1973b) and the Joint Facilities Act (SFS, 1973c). A real property unit (in Swedish: fastighet) is in the Land Code described as that real property is land, which is divided into property units. It should be noted that the Land Code does not exclude air and water from the concept of land.
Swedish real property can be classified into traditional real property that is owned by a private (or legal) person through individual ownership, or common ownership. A rather new concept is the existence of three-dimensional (3D) real property. There are approx. 3.2 million real

property units registered in the Real Property Register. There also exist a limited number of other, rather archaic, types of real property. An example is the shared property (in Swedish: andelsfastighet), only existing as shares in one or more real properties. Another type of real property is the exclusive right to fish in certain streams and lakes. The right normally is connected to a number of (rural) properties. Another type of real property is the exclusive right to fish in certain streams and lakes. The right normally is connected to a number of (rural) properties. The title to the fishing right may be separated from the title of the land and can be part of another real property or even exist as a real property in itself. This real property unit does not have a specific name in Swedish legislation, but is today sometimes named "fishery property" (in Swedish: fiskefastighet). An example is an old fishing right not connected to the title of the land, the "land book fishery" (no official English translation has been found, but the term has been translated directly from the Swedish term "jordeboksfiske").

These examples illustrate the complexity of traditional ownership, but other types of RRRs exist to manage the (legal) relations between owner/user and land. The major RRRs are joint property unit, site leasehold, joint facility, easement, public road right and utility easements. There are also a number of historical rights registered in the Real Property Register.

Joint property unit: Land (and water) can be legally attached to two or more real property units by forming a joint property unit (in Swedish: samfällighet). A joint property unit can e.g. be used for extracting natural resources like timber or fish, or used as grazing pasture for animals benefitting several real properties in a local community. The shares are attached to the real properties being part of the joint facility, not their owners. The share in the joint property unit follows the property if a shareholder property is sold. The registration includes unique real property and joint property unit identification numbers as well as area identification numbers, municipality in which it is located, etc.

Site leasehold: A site leasehold (in Swedish: tomträtt) is a right to use a specific part of a real property owned by a municipality, the State, or otherwise in public possession, to erect a house for dwelling purposes. The use of site leasehold was popular in urban areas in the first half of the 20th century, offering plots of land to citizens who could not afford to purchase a real property unit. The right is granted for an undefined period of time, and cannot be cancelled by the state or municipality. The lessee pays a yearly payment. The payments are regulated by the land owner and fixed for certain periods. It is possible for the lessee to buy the plot of land, thus becoming the owner of a real property unit. Site leasehold is a very strong right and almost equal to ownership. The rightsholder owns the buildings, etc. constructed on the site-leasehold plot. The right can be sold on the open market. If the land owner wants to end the site leasehold, procedures similar to expropriation apply.

Joint facility: A joint facility right (in Swedish: gemensamhetsanläggning) is a right for a construction (facility) beneficial for two or more real property units. Examples are private roads, a bathing jetty or a parking area where the owners of the properties have a common interest in using or maintaining the facility. When a joint facility no longer has any use it may be physically removed, or just being abandoned or in some cases still exist as a ruin. They however still exist as a right in the register, if they have not been removed through a cadastral procedure that is normal, but resulting in some inconsistency between the real world and the Real Property Register (Paasch et al., 2017).

Easements: An easement (in Swedish: servitut) is a right executed by a real property (the dominant tenement) to use a specific part of another real property (the servient tenement),

such as the right to keep and maintain an electric cable on a property, or the right of way over a neighbouring property. An easement can even, however uncommon, be unspecified such as the right to drill and use a well on another property, where the exact location of the well is not described. The easement is created by cadastral procedure. The right is registered in the FR today, but rights created prior to 1972 may not be registered. It is even possible to create an easement by private agreement (in Swedish: avtalsservitut). It is not mandatory, however recommended, to register these private easements in the register. They still have legal force, even if not registered. The purpose of an easement can be formulated in free text, but Lantmäteriet has produced examples to be used in order to facilitate the use of standardised descriptions in the cadastral documents (Lantmäteriet, 2024).
Public road right: Public road right (in Swedish: vägrätt) is a right where the road manager (State or municipality) is granted the use of (parts of) real properties for construction and maintenance of public roads. The right holder, in principle, takes over (almost) all ownership rights from the property owner. The right holder takes the owner's place and may allow certain constructions within the road area. The right is granted to ensure control of land occupied or used in the construction and maintenance of public roads.
Utility easement: Utility easement (in Swedish: ledningsrätt) is a right allowing a person to use a space within the property for construction and maintenance of an installation used for the common good, e.g. an electric cable or a pipeline for water supply.
Historical personal rights: Some historical rights not granted anymore also exist, such as the right to electrical power (in Swedish: rätt till elektrisk kraft), and a right for a person to receive benefits in form of money or goods from a real property (in Swedish: avkomsträtt). The historical rights are registered in the FR.
Lien, Mortgage lien: A mortgage lien (in Swedish: panträtt) in an instrument for security in registered real property. The right allows security for loans through mortgaging of real property and certain rights in real property (site-leasehold). A real property can only be mortgaged as a whole because a joint owner cannot mortgage a single share of the real property. Mortgage lien is registered in the FR.

4. DISCUSSION AND CONCLUSIONS

The Swedish LADM model presented in this paper is only illustrative and discusses the complexity of Swedish RRRs as an early step in producing a national Swedish model, since the legal basis for the future content and structure of the register is yet unsure. It is important to align the model with the upcoming modernisation of the Real property Register legislation in order to follow the proposed legislative changes and their impact on the components of a possible LADM model for Sweden. However, we believe that the initiation and preparation can be made at this stage on a more conceptual level.
For the future work, considering the unique characteristics of Sweden's land administration system, the core LADM classes will be customized to reflect the specific requirements of the Swedish context, including attributes and relationships for parties, rights, spatial units, and administrative units. Relationships and associations between these classes will be established to accurately represent the interactions and dependencies within the Swedish land administration system. In addition to the more general and most basic RRRs presented in this paper, additional and more detailed RRRs will be included and further elaborated. The later

steps in the proposed research methodology to develop the Swedish LADM II-based country profile will include these aspects and are planned for continued research on this topic. Of use then will be the methodology presented by Kalogianni et al. (2021), as well as lessons learned from the already developed country profiles from other countries.

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BIOGRAPHICAL NOTES

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