SDG Land Administration Indicators based on ISO 19152 LADM

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Key words: ISO 19152 LADM, SDGs, Land administration indicators

SUMMARY

The Sustainable Development Goals (SDGs), comprising of 17 Global Goals, serve as a global framework for addressing various facets of sustainable development. Several of these goals emphasize the crucial role of land management and equitable land distribution in achieving sustainable development objectives. ISO 19152, known as the Land Administration Domain Model (LADM), plays a pivotal role in land administration systems globally. It provides a standardized framework for land management, including land tenure, marine georegulation, valuation, and spatial plan information.

This paper explores the integration of land administration indicators within the ISO 19152 standard, aligning them with the United Nations Agenda 2030 SDGs. The process involves a systematic approach to selecting and developing these indicators. In the indicator selection phase, firstly, we establish the foundational lexicon linked to LADM then extract lexemes from SDGs indicators, analyze their semantic relationships, and evaluate their alignment with LADM; secondly, we meticulously evaluated chosen indicators by analyzing their SDG indicator metadata, focusing on the “Method of Computation" section to align these indicators with LADM's basic classes; thirdly, categorizing them based on their association with LADM. This categorization ranges from indicators with no direct correlation to those with full computational interdependence, specifically, they are: Non-Association (Category 0), Full Computational Association (Category 1), Partial Computational Association (Category 2), Indirect Association (Category 3), Association with Other International Standards (Category 4). Following indicator selection, our approach to indicator development is summarized. This entails expressing information from UN SDG "Method of Computation" documents in UML class diagrams, adding operation names and parameters to the most relevant class, and specifying implementation methods for each operation. An in-depth analysis of SDG Indicator 1.4.2 demonstrates the feasibility of deriving indicators entirely from LADM data.

Finally, the paper discusses potential future work, including the integration of semantic networks and ontologies for keyword extraction, further exploration of Category 1 Indicators, and practical implementation through case studies, data collection, indicator testing, validation, and reflection.

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1. INTRODUCTION

The Sustainable Development Goals (SDGs), a set of 17 Goals, is a global plan of action for people, planet, prosperity, peace, and partnership (United Nations General Assembly, 2015). Among these goals, some are intricately tied to the realm of land, emphasizing the critical importance of effective land management and equitable land distribution for sustainable development. In this context, land administration plays a pivotal role in ensuring the efficient management and just allocation of land resources (UNGGIM, 2020).

ISO 19152, the Land Administration Domain Model (LADM), is a prominent international standard in the field of land administration providing a comprehensive framework that defines conceptual models and standardized methodologies for land administration systems. LADM serves as a crucial tool for nations seeking to enhance their land administration systems, thereby promoting sustainable utilization of land resources and equitable distribution (ISO, 2012). In this paper the new edition of LADM (currently under development) with a wider scope, including land tenure, marine georegulation, valuation, and spatial plan information, is used.

This research endeavor seeks to contribute to the advancement of land administration indicators that align with the United Nations Agenda 2030 SDGs and the ISO 19152 LADM standard. Consequently, the primary aim of this research is to identify the pertinent land administration indicators delineated within the SDGs, with the objective of integrating them within the framework of LADM. This integration is envisioned to provide an effective means to gauge land governance and tenure systems, aligning them with the sustainable development agenda.

Three fundamental hypotheses underpin this ongoing study:

1. By amalgamating the standardized principles and methodologies of ISO 19152 LADM with the overarching goals and targets of the UN Agenda 2030 SDGs, the resulting land administration indicators will manifest as more comprehensive, accurate, and representative.

2. The utilization of these indicators has the potential to bolster evidence-based policy-making, thereby substantively contributing to the realization of SDGs.

3. The effectiveness and expediency of indicator computation can be significantly enhanced through continuous updates to the Land Administration System (LAS).

The rest of this paper is structured as follows: the second section encompasses background information, elucidating the LADM and SDGs; the third section delineates the process of indicator selection, including the method and workflow followed in this paper. Furthermore, the next section gives the indicator development process; the fifth section presents results and examples by selecting a representative indicator and applying the aforementioned processes; and finally, conclusions and proposals for future research are presented.

2. BACKGROUND

In this section the necessary background information and concepts addressed in this paper are introduced. Firstly, the basic concepts of LADM and the developed version, then a quick review of SDGs, which is well known.

2.1 ISO 19152:2012 LADM basic concepts and ongoing revision

ISO 19152 LADM, the Land Administration Domain Model, is an international standard and a conceptual framework (ISO, 2012). It serves the purpose of describing land administration systems, focusing on aspects related to land rights, responsibilities, restrictions, and their geospatial components. The primary goal of this standard is to facilitate communication among various parties, both domestically and internationally, by providing a shared vocabulary (ontology) and a formal language (Unified Modeling Language, UML) to describe people-to-land relationships. It does not intend to replace existing systems but rather serves as a descriptive tool for these systems, enhancing the comprehension of their similarities and difference. While LADM is a generic model, it can be extended and customized for specific regions or countries, making it a versatile tool in the field of land administration.

Widely adopted by international organizations(UNGGIM, 2018) like the United Nations and the World Bank, LADM serves as a common language for different stakeholders such as land surveyors(Aditya et al., 2021), land registrars(Beck et al., 2021) and land managers(Lisjak et al., 2021) and therefore, the first edition of the standard has been widely known around the world, with various country profiles being developed as reported by(Kalogianni et al., 2021). Currently, around ten countries around the world have implemented LADM as a part of their land administration systems, including Scotland, Indonesia and Colombia, while more than 15 countries have adopted the Social Tenure Domain Model (STDM), a specialized solution based on LADM, including Democratic Republic of the Congo, Kenya and Lao PDR(Njogu et al., 2023).

The scope of LADM Edition I is limited to the land tenure component of the LA paradigm (see the grey circle in Figure 1), whereas LADM Edition II aims to extend the scope of Edition I to include land value, land use and land development (red circle in Figure 2) (Kara et al., 2023).

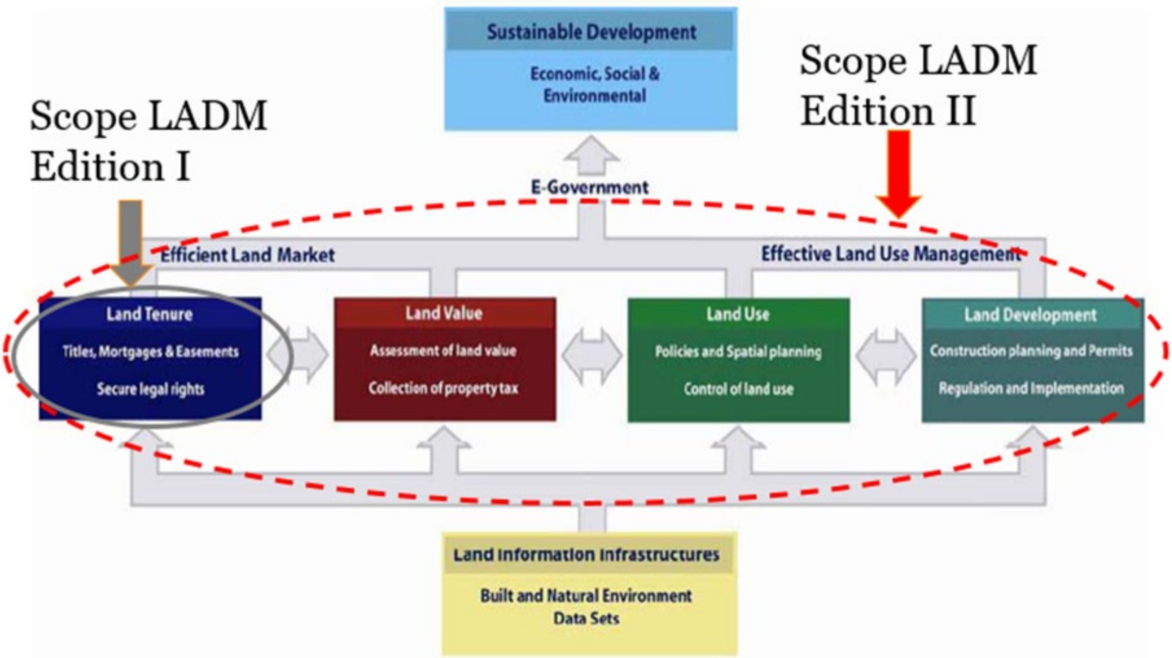

Figure 1. Land Administration paradigm and LADM scope (Kara et al., 2023; adapted from Enemark, 2006**)**

Currently, the second edition of LADM is under development, comprising of six parts (Figure 2), which build upon the solid foundation laid by the initial standard. This expanded edition encompasses a range of crucial domains, including Marine Georegulation, Valuation Information, and Spatial Plan Information. Kara et al. (2023)provide a detailed overview of the latest developments of the second edition of the standard.

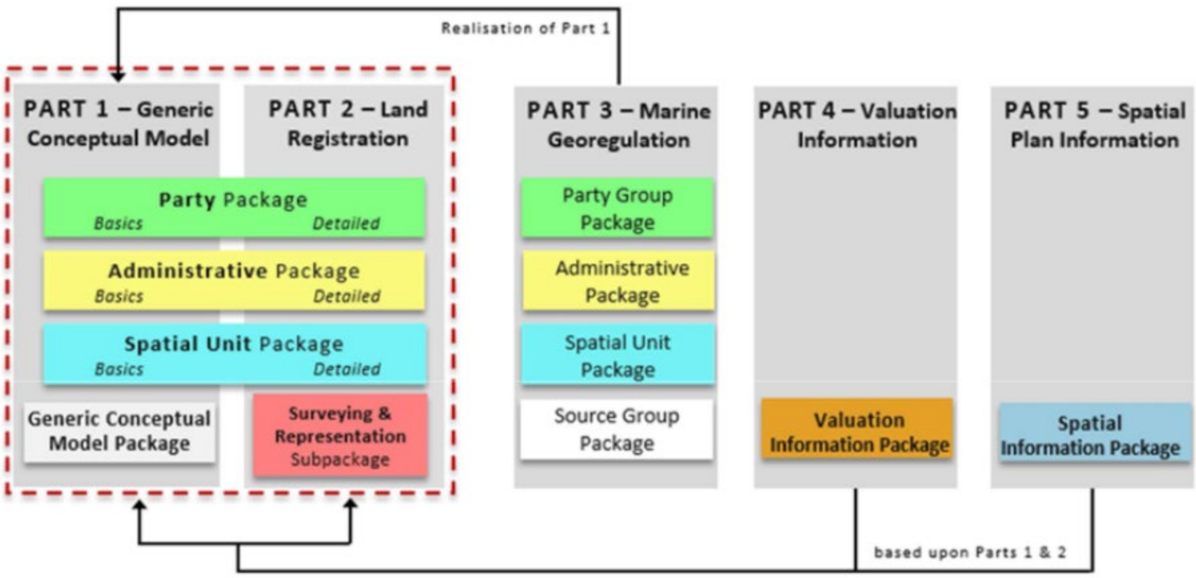

Figure 2. LADM Edition II Parts 1-5 (Kalogianni et al., 2023)

2.2 SDGs and Land

The SDGs are broad in scope, comprising 17 overarching goals, 169 targets and 248 different indicators (of which 231 are unique), some of which are further subdivided into sub-indicators (e.g., indicators 1.4.2, 5.a.1, 11.5.3, etc.). The SDGs aim to address a range of social, economic and environmental challenges facing the world. Land underpins the SDGs as it covers many of the goals, particularly those related to the environment, food security, economic development, urbanisation and climate change.

3. INDICATOR CLASSIFICATION AND SELECTION

A systematic methodology is developed for the purpose of refining and discerning indicators from SDGs of relevance to the objective of this paper and is in line with the LADM, as presented in Figure 3. The Steps are explained at the following paragraphs.

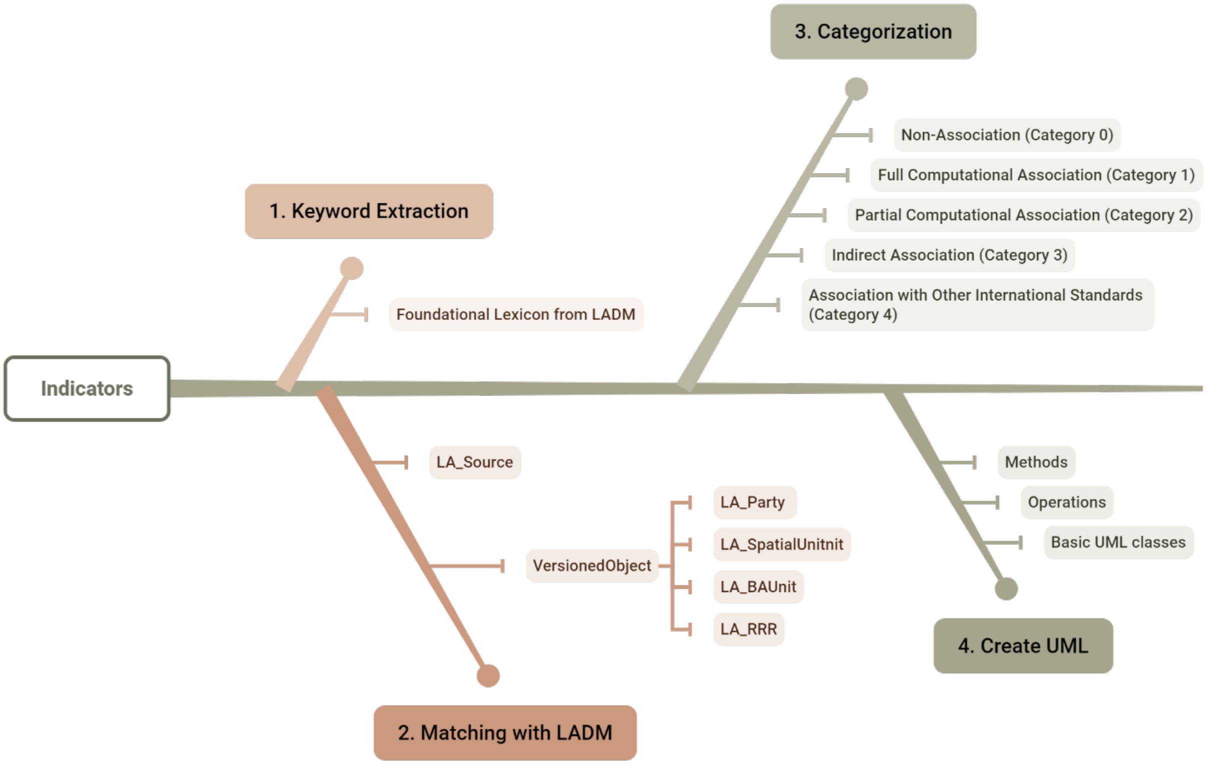

Figure 3. General Flow

3.1 Step 1: Keyword Extraction and Preliminary Filtering:

First and foremost, it becomes indispensable to use the core terminology of the LADM to create a first filtering for the identification of the relevant indicators. The core terms constituents: Land, Party, RRR (Rights, Responsibilities, Restrictions), Spatial Units, Marine, Valuation and Spatial Plan.

At the documents of the various parts of the LADM Edition II that are being submitted in the different stages of the standardization process, the definition of these terms is provided. Specifically:

1. **Land**: spatial extent that is defined by RRRs and encompass the surface of the earth, strata, sub-strata or the marine environment, like a building;
2. **Party**: person or organization that plays a role in a rights, responsibilities or restrictions transaction, like natural person;
3. **Rights**: formal or informal entitlement to own or do something;
4. **Responsibilities**: formal or informal obligation on the land owner to allow or do something;
5. **Restrictions**: formal or informal obligation on the land owner to refrain from doing something;
6. **Spatial Units**: the areas of land (or water – e.g., water rights and the marine environment) where the rights and social tenure relationships apply;
7. **Marine**: relating to navigation or shipping; relating to or connected with the sea; used, or adopted for use at sea;
8. Valuation: process of estimating value of an immovable property;
   a. **value**: value of a property or a property unit estimated under certain assumptions at a particular moment of time;
9. **Spatial Plan**: a set of documents that indicates a strategic direction for the development of a given geographic area, states the policies, priorities, programs and land allocations that will implement the strategic direction and influences the distribution of people and activities in spaces of various scales;
   a. **plan** unit: homogenous smallest area/space (2D/3D) with assigned function/purpose to represent the potential land use development according to the spatial planning authorities at the highest detail, largest scale (usually the municipality/ neighborhood level)
10. Source: document providing legal and/or administrative facts on which the LA object (right, restriction, responsibility, basic administrative unit, party, or spatial unit) is based on.

Subsequently, relevant terminology from the SDGs indicators is extracted. Meanwhile, the complex semantic interplay among these extracted terms, decodes the relationships that may encompass synonymy, hypernymy, or contextual relevance. Each term is subjected to careful evaluation, gauging its alignment with the core LADM terminology, thereby facilitating the creation of a semantic bridge between the landscape of SDGs and the land administration domain. This reveals the consistency and nuances of expression between the terminology of the SDGs and LADA, thus laying the foundation for harmonization between the two areas.

3.2 Step 2: Matching with LADM core classes

The selected indicators underwent a rigorous evaluation process, which involved a comprehensive analysis of their corresponding SDG indicator metadata documents(United Nations, 2023) and a rigorous matching process.

A key aspect of this evaluation was the meticulous examination of specific sections within the indicator metadata documents(United Nations, 2023), namely, “0.f. Related indicators”, “2.a. Definition and concepts”, “3.a. Data sources” and “4.c. Method of Computation”. Briefly:

1. **For “0.f. Related indicators”**, it identified related indicators to understand their connections and potential overlaps, aiding in defining the evaluation scope, like for Indicator 5.1.1 “*Whether or not legal frameworks are in place to promote, enforce and*

monitor equality and non-discrimination on the basis of sex", to avoid duplication, it does not cover areas of law that are addressed under indicator 5.a.2 *"Proportion of countries where the legal framework (including customary law"* guarantees women's equal rights to land ownership and/or control);
2. **For "2.a. Definition and concepts",** it provides explanations for the more generalized text used in the indicators. For example, for indicator 1.4.1, "*Proportion of population living in households with access to basic services*", the precise definition of "basic services" is elaborated upon;
3. **For "3.a. Data sources"**, it gives information on the potential databases and the organizations responsible for data collection, allowing for a quick assessment of whether they are relevant to the data involved in LADM;
4. **For "4.c. Method of Computation"**, the specific calculation methods for each indicator are detailed, which encompasses a variety of approaches, like the formulation of mathematical equations, tabulated scoring systems, etc. This section also plays a pivotal role in the subsequent classification of indicators.

This thorough analysis was instrumental in ensuring the accuracy and reliability of the chosen indicators, as it provided a deep understanding of the conceptual framework and technical aspects underpinning them.

Subsequently, a rigorous alignment process was conducted, associating the basic classes (and sub-classes) from the various parts of LADM Edition II with these selected indicators. As previously mentioned, the basic classes are LA_Party, LA_SpatialUnit, LA_BAUnit, LA_RRR, VM_ValuationUnit and SP_PlanUnit and they are all inheriting from VersionedObject (and associated to LA_Source). For those indicators that could be matched and have clear calculation formulas, the data names that LADM couldn't provide and might require sourcing from external datasets should be noted.

3.3 Step 3: Indicator Categorization:

In this pivotal third step, a comprehensive classification of the selected indicators was executed, grounded in their nuanced relationships with the Land Administration Domain Model (LADM). The categorization criteria employed are elucidated as follows:

1. **Non-Association (Category 0)**: These indicators demonstrate no discernible direct or computational correlation with LADM.
2. **Full Computational Association (Category 1)**: Indicators falling within this category exhibit an unequivocal and comprehensive computational interdependence with LADM. All the data required for the calculation of these indicators can be obtained from a Land Administration System that conforms to the LADM.
3. **Partial Computational Association (Category 2)**: These indicators, while partly reliant on data provided by LADM for their calculations, necessitate additional external data sources. They thus establish a partial computational nexus with LADM.
4. **Indirect Association (Category 3)**: LADM offers supportive roles during the indicator generation process.
    a. Indicator involves LADM elements (classes or attributes) but lacks direct expression (and therefore calculation) within the structure of the model. For example, for the indicator "*14.6.1 Degree of implementation of international*

instruments aiming to combat illegal, unreported and unregulated fishing", the computation method is based on surveys and scoring, and it is related to elements such as marine and land rights within LADM.
   - **b.** Indicator indirectly utilizes LADM elements, and their final expressions do not have directly relation with LADM. For instance, the indicator "*1.2.2 Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions*", "Poverty" includes a "housing" dimension, which is related to "BAUnit".
5. **Association with other Standards (Category 4):** Indicators categorized as such are fundamentally linked with other (international) standards in order to be computed and potentially may partly rely on the LADM.

3.4 Step 4: Create UML

This last step focuses on describing the computational process of the indicator within the UML diagram. Specific processes and examples are presented in the Chapters 4 and 5.

4. INDICATOR DEVELOPMENT

Following the categorization into the distinct classes, the next crucial step is the actual development of the indicators. This process involves translating the indicator's computational requirements and dependencies into practical and systematic implementations. The following approach is used to document the indicator development:

1. **Representation with UML**: To begin, the information stipulated in the "4.c. Method of Computation" was meticulously expressed using UML (Unified Modeling Language) class diagrams. Here there can be various cases:
   - **a.** information is based on in LADM,
   - **b.** information is based on in other standards (e.g., ISO 19144 (ISO, 2012)),
   - **c.** information is not known based on a standard, but can be extracted from other databases (this is modelled via blueprint/external classes diagram to be developed to capture description of this information in the UML)
2. **Add compartment**: For the most relevant class, a dedicated compartment is used in the computation of the indicator values. This compartment contains the name and parameters of the added operations. Please note that the spatial extent (whole country, province, municipality) and temporal extent (decade, year, month) may vary. A typical operation could be to compute an indicator value in a specific year and for a specific area; e.g., compute indicator X (year, area).
3. **Implementation Method**: For each operation, a well-defined implementation method is specified within the UML diagram. This includes an attached note defining the steps of computation. The implementation methods are articulated using programming languages (i.e., Python, Java, pseudo code). Crucially, these methods were aligned with the information elements delineated in the utilized UML classes.

This systematic approach ensures a structured and comprehensive documentation of indicator development, facilitating clarity and transparency in the computational processes associated with each indicator

5. USE CASE INDICATOR DEVELOPMENT

For the comprehensive understanding of the indicator selection and development, the SDG Indicator 1.4.2 "Proportion of total adult population with secure tenure rights to land, (a) with legally recognized documentation, and (b) who perceive their rights to land as secure, by sex and type of tenure" is selected for in-depth analysis. Firstly, the classification into the categories mentioned in the previous sections is carried out and as a second step the computational method of the indication development is presented and visualized in UML.

5.1 Indicator classification

<u>Step 1: Keyword Extraction:</u>
Firstly, in order to make an initial judgement on whether the SDG 1.4.2 indicator is related to LADM, the indicator description needs to be analyzed. The process of "Identification of Noun Phrases - Filtering Redundant Vocabulary -" was used, as shown in Figure 4.

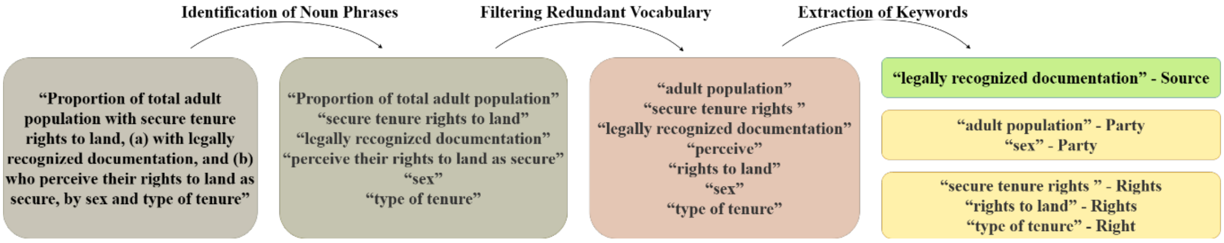

Figure 4. Keywords Extraction for SDG 1.4.2

According to the Figure 4, the keywords include "legally recognized documentation", "adult population", "sex", "secure tenure rights", "rights to land" and "type of tenure", and their corresponding LADM core terms are "Source", "Party" and "Rights". Therefore, we can now tentatively SDG 1.4.2 indicator is somewhat related to LADM.

<u>Step 2: Matching:</u>
In the SDG Indicator1.4.2 metadata document(United Nations, 2023), according to the "2.a. Definition and concepts" section, we can find that the indicator are divided into 2 parts:

- Part (A) quantifies the proportion of adults possessing legally recognized documentation over land within the total adult population.
- Part (B) emphasizes the proportion of adults who perceive their land rights as secure within the adult population.

Mathematically, these parts are represented as follows:

$$\text{Part (A): } \frac{People\ (adult)\ with\ legally\ recognized\ documentation\ over\ land}{Total\ adult\ population} \times 100$$

$$\text{Part (B): } \frac{People\ (adult)\ who\ perceive\ their\ rights\ as\ secure}{Total\ adult\ population} \times 100$$

Therefore, to meet the metadata documentation requirements, it is necessary to collect three types of data: (a) the number of adults possessing legally recognized documentation over land (for Part A), can be derived from a cadastre system compliant with LADM; (b) the number of adults who perceive their land rights as secure (for Part B), can only be obtained through household survey (or relevant historical data stored in external databases); and (c) the total adult population (for both), made available from censuses or inter-censual projections.
Therefore, based on the analysis carried out, the following conclusions were drawn:

- "Secure tenure rights" and "Type of tenure" are related to LA_RRR (Rights, Responsibilities, Restrictions) class due to its connection to the nature of land rights.
- "Legally recognized documentation", as mentioned in the metadata file, is legal documentation of rights refers to the recording and publication of information on the nature and location of land, rights and right holders recognized by government. So, it is related to LA_Source.
- "Sex" could be an attribute of LA_Party.

<u>Step 3: Classifying:</u>
Finally, the SDG 1.4.2 indicator was categorized based on its relationship with LADM. The specific categorization is as follows:

- SDG Indicator 1.4.2 (a) is classified under the "Partial Computational Association (Category 2)". SDG Indicator 1.4.2 (b) is categorized under the "Indirect Association (Category 3)". So, SDG Indicator 1.4.2 is classified under the "Partial Computational Association (Category 2)".

5.2 Indicator development

Based on the steps of indicator development mentioned in earlier sections, the computation of SDG Indicator 1.4.2 is shown via UML diagram. In Figure 5, distinct colors are employed to enhance readability; with yellow representing classes belonging to VersionedObject, green denoting LA_Source, red signifying external classes, and blue indicating methods that implement operations.

The specific steps in the modeling process are as follows:

1. **UML Diagram Representation**: To begin, the core components of the LADM, including LA_Party, LA_RRR, LA_BAUnit, and LA_Source into the UML diagram describing the indicator computation are introduced.To fulfill the requirements of SDG Indicator 1.4.2, an external class named "SecureLandRightAdult" is introduced to represent the molecular aspect of Part B and an external class named "Population".

2. **Addition of Attributes and Operations**: Within the LA_Party class, emphasis is given on key attributes:
   a. "birth day" is employed for subsequent identification of adults in relevant calculations.
   b. "gender" serves the purpose of categorizing adults.

   Additionally, we introduced vital operations:
   c. "countAdult" facilitates the determination of the total count of adults.
   d. "hasLegalLandCertification" is crucial for verifying whether this party possesses legal documents related to land.

   Furthermore, focus was given on the LA_Right class and specifically the attribute "LA_RightType" that categorizes the various types of land tenure, aligning with the "type of tenure" parameter in the indicator.

   An external class, the SecureLandRightAdult is introduced and features information further aiding in adult identification, while operations designed to assess the perception of land rights are introduced, including:
   a. "Perception" which signifies the degree of land rights security. It utilizes the LandRightPerception codelist encompassing values like +0 - insecure and +1 - secure.
   b. "PerceiveRightAsSecure()" an operation that determines whether land rights are perceived as secure, yielding a Boolean outcome.

3. **Implementation Method**: To carry out the "+ countAdult" operation effectively, the following pseudocode has been developed. It outlines the steps for counting adults based on their birth dates. It initializes a counter, retrieves the current date, and then iterates through each individual's birthdate. Using the "calculateAge" function, it determines their age and increments the count if the age is over 18. Finally, the operation returns the total count of adults.

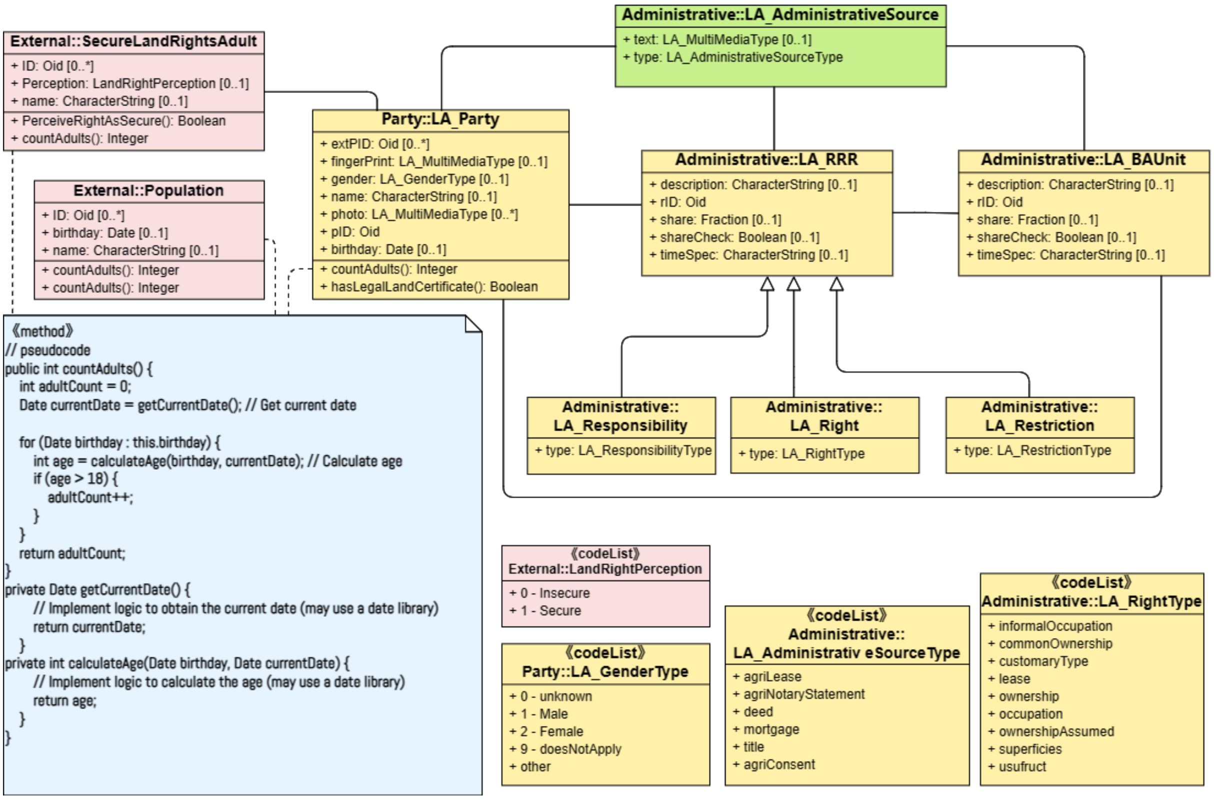

Figure 5. Modelling of SDG Indicator 1.4.2 calculation in UML class diagram

6. CONCLUSIONS AND FUTURE WORK

In the context of this paper, an investigation of the relevance between SDGs and LADM is carried out, aiming to provide initial results of how (and if) relevant indicators can be computed (directly or indirectly) through LADM. Therefore, a comprehensive classification and analysis of a range of SDGs is conducted to assess their degree of association with the LADM, leading to the following key categories:

1. Category 0 Indicators: In total, 220 indicators are identified falling into this category, indicating no direct association with LADM. These indicators do not require any data or information related to LADM in their computation processes.
2. Category 2 Indicators: A total of 10 indicators were identified in this category, which. partially rely on data provided by LADM for their calculations but may also require additional external data. These indicators span various domains, including land use, water resources management, road connectivity, and more.
3. Category 3 Indicators: There are 11 indicators in this category, that lack explicit computational formulas, LADM has an indirect impact on the results of these indicators. This implies that LADM plays a supportive role in the indicator generation process, particularly in land use planning and forest management.
4. Category 4 Indicators: In total, 6 indicators are identified in this category that are closely related to other (international) standards and may require the concurrent use of LADM to meet international compliance requirements for their computation. They

cover various domains, such as land ownership, water resources management, and land use planning.

The selected indicators cover a wide range of areas, including poverty, basic services, land rights, economic losses, agriculture, drinking water, water management, transport, housing, land use, watershed management, forests and protected areas. However, for different category, they have different focus. Category 2 underscores the significance of secure land tenure rights, scrutinizing both legally recognized documentation and the perception of land rights as secure, with a distinct focus on gender equality. In Category 3 indicators probe into the dimensions of poverty concerning housing, accessibility to potable water, and the legal frameworks governing land and water rights, including aspects of gender equality. Furthermore, Category 4 delves into the domain of Environmental Preservation, encapsulating the coverage of protected areas, forestland, and the impact of land degradation. It appears that for Category 1, there are currently no indicators that can solely rely on LAS in line with LADM. However, this observation also highlights the strong relationship between land administration and various sustainability goals and indicators. While direct indicators within Category 1 may not be present, it is evident that land administration and specifically, LADM play a vital role in supporting and contributing to the achievement of broader sustainability goals across different categories and indicators.

This paper presents a preliminary analysis and results regarding LADM and SDG, providing solid ground for future work. Important topics for further exploration are:

1. **Semantic Network and Ontology Integration:** The initial step of indicator selection, which involves Keyword Extraction and Preliminary Filtering, as presented relies on manual literature review. A promising avenue for future research lies in the adoption of advanced semantic network techniques and ontology construction methods. Leveraging these technologies could streamline the process by automating keyword extraction and enhancing the precision of indicator selection. This approach would not only expedite the process but also reduce the potential for bias in keyword selection.
2. **Further Exploration of Category 1 Indicators:** At present, no Category 1 Indicators (those that can be entirely derived from LADM data) . In light of the aforementioned recommendation, next step would be to revisite this category by employing advanced techniques to explore the possibility of identifying indicators that can be exclusively derived from the Land Administration System and LADM-compliant data sources.
3. **Practical Implementation and Case Studies:** Current work of this paper has predominantly focused on theoretical aspects and future work includes encompassing practical implementation. This includes:
    a. **Case Study:** Undertaking a comprehensive case study within a specific country or region to assess the developed indicators in a real-world context. This endeavor would aim to evaluate land governance and tenure using (3D) Land Administration Systems (LAS) based on LADM. The study would address fundamental questions such as "*How can LAS be assessed using these indicators?*" and "*How can the assessment outcomes be effectively visualized?*"
    b. **Data Collection:** Detailing the process of collecting relevant data for the case study, encompassing a wide array of sources such as land administration records, survey data, remote sensing data, or any pertinent information

necessary for computing the selected indicators, ensuring transparency and reproducibility.

c. **Indicator Testing and Validation:** Conducting rigorous testing and validation of the selected indicators using the collected data. This phase would involve the calculation and analysis of the indicators, followed by a comparative analysis with existing methods or indicators. Key questions to address would include "*How do the results of the newly computed indicators compare with existing methods?*" and "*What are the relationships between the values of newly computed indicators and those reported by current methods?*" This phase would also assess the validity and reliability of the newly computed indicator values.

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BIOGRAPHICAL NOTES

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Peter van Oosterom obtained an MSc in Technical Computer Science in 1985 from Delft University of Technology, the Netherlands. In 1990 he received a PhD from Leiden University. He is professor at the Delft University of Technology, and head of the 'GIS Technology' Section, Department OTB, Faculty of Architecture and the Built Environment, Delft University of Technology, the Netherlands. He is the current chair of the FIG Working Group on '3D Cadastres'.

Eftychia Kalogianni is a PhD candidate in GIS Technology' Section at the Faculty of Architecture and the Built Environment, Delft University of Technology in the Netherlands. Her PhD research topic is about adopting a holistic approach to treat 3D Cadastres within the spatial development chain. She holds a MSc in Geoinformatics from NTUA and a MSc in Geomatics from TU Delft. In 2012, she received a diploma in Rural and Surveying Engineering from National Technical University of Athens.Since 2015, she works at a consulting engineering company. She is an active member of FIG Young Surveyors Network.

Paula Dijkstra obtained a Master's degree in Social Geography and a specialization in cadastral data acquisition and 3D modelling. Since 2011, she has been working for the international department of Kadaster. She currently serves as the Director of Kadaster International, where she oversees the coordination of Kadaster's international activities and international cooperation projects. Kadaster International offers advisory services globally in areas such as land administration, e-governance, geo-information services, and SDI.

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