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LADM for sustainable development: An exploratory study on the application of domain-specific data models to support the SDGs

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SUMMARY

Individual land titling will not deliver land tenure security to the majority of people by 2030. Nevertheless, tenure security is implicit to the 2030 Agenda for Sustainable Development and deep-rooted in the Sustainable Development Goals (SDGs). Land tenure security underpins the SDGs related to poverty reduction, food security, disaster risk management and gender equality. The cross-cutting benefits of land tenure security with regards to sustainable development suggests equally cross-cutting conceptual frameworks, management cooperation and data sharing are needed within, and between, those sectors. Additionally, previous research in the land administration domain developed approaches, frameworks and data models linking across different domains. This latter achievement showed how developments using standardised modelling approaches and domain terminologies can be used to support gathering, organising and disseminating information relevant to reporting on and monitoring of the SDGs. From the perspective of data sharing, domain models - such as the Land Administration Domain Model LADM (ISO 19152), a globally recognized standard - are seen as supporting this capability. In response, this paper explores whether and how LADM, in terms of data model additions and adaptations, could support other SDG-relevant domains. The approach used is exploratory, including elements of literature review, case study analysis, conceptual data modelling, and synthesis. It shows the potential and added value of an integrated data modelling approach, with regards to Land Administration and its intrinsic feature to other fields of study including poverty reduction, food security, and gender equality.

1. Introduction

Individual land titling will not deliver land tenure security to the majority of people by 2030 (Zevenbergen et al., 2013). This is important with regards to global development: increasing tenure security is implicit to the achievement of the Agenda for Sustainable Development and its defined Sustainable Development Goals (SDGs) (UN, 2015). Land tenure security underpins the SDGs related to poverty reduction, food security, disaster risk management and gender equality. The cross-cutting benefits of land tenure security with regards to sustainable development suggests equally cross-cutting conceptual frameworks, management cooperation and data sharing are needed within, and between, those sectors (Unger et al., 2020a).

From the perspective of data sharing, domain models - such as the Land Administration Domain Model LADM (ISO 19152), a globally recognized standard - are seen as supporting this capability. However, typically such standards are developed within, and for, a specific domain: data or knowledge silos are a common (UN-GGIM, 2020). Although work on the second iteration of the LADM standard is focusing on extensions into land valuation and land use planning, for example, until now, the ability to apply and extend a domain-specific data model, such as LADM, has not received detailed analysis.

In response, this paper aims to explore whether and how LADM, in terms of data model additions and adaptations, could support other SDG-relevant domains. The approach used is exploratory, including elements of literature review, case study analysis, conceptual data modelling, and synthesis. The idea of research generalisation is also utilized.

The remainder of the paper is structured as follows. First, to provide a stronger justification for the investigation, a brief background on the SDGs, interoperability, standards, ISO, and LADM is provided. A methodology to enable the exploratory generalisation work is then outlined. This leads to presentation of the results: i) the case overview of an application of LADM into Disaster Risk Management (DRM), via the LA-

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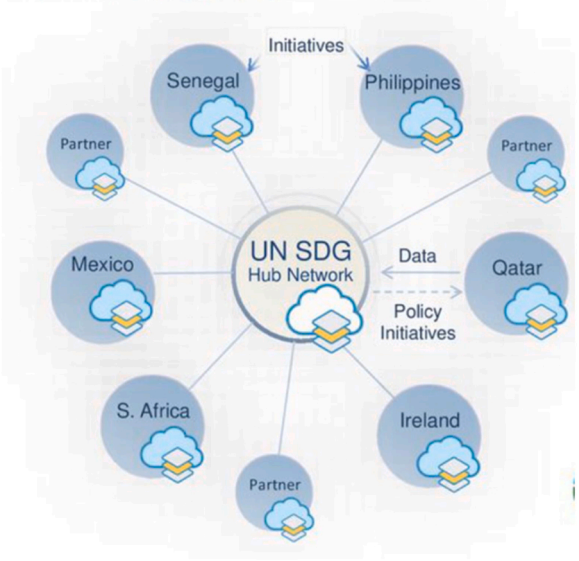

Fig. 1. Example UN SDG Hub Network as presented in (United Nations, 2020).

DRM data model and its application in Nepal; and ii) conceptual modelling work to examine the potential to apply LADM into other SDG. Finally, conclusions on potential next steps for further LADM dialogue and application into other SDG-relevant domains.

It should be noted that this work does not seek to examine the level of detail to describe all queries which could be generated or potential additions and adaptions of LADM classes and attributes to support all SDGs. Instead, the specific focus is to illustrate the potential and simplicity in utilizing an already existing globally recognized data model standard, to support the 2030 Agenda.

2. Background on SDGs, data interoperability, and LADM

At a conceptual level, interlinked frameworks to support SDGs achievement are already observable (Unger et al., 2017; Asiama et al., 2019; Shreshta, 2019 and others). Asiama et al. (2019) examine how contemporary land consolidation activities in Sub-Saharan Africa contribute to the achievement of the SDGs through land tenure security, food security and rural development initiatives at country level. Unger et al. (2017) illustrate linkages between the domains of disaster risk management (DRM) and LA by showing the overlaps and interlinkages between key constructs and processes: the contribution of responsible LA to DRM is shown via three categories: i) census data provision, gathered through participatory enumeration; ii) tenure security through application of the continuum of land rights; and iii) hazard risk assessment and mapping. Additionally, a data model, linking the LA and DRM domain was developed (Unger et al., 2019a). This latter achievement showed how data models, developed using standardised modelling approaches (e.g., UML) and domain terminologies (e.g. LA), such as the LADM (ISO 19152), can be used to support gathering, organising and disseminating information relevant to reporting on the SDGs. Moreover, the UML-based approach actually supports the dialogue and cooperation between sectors, required for the SDGs achievement. The work tends to confirm the statement by Hakan Murby, then president of ISO in 2007, that 'standardisation has the potential to play a leading role in promoting sustainable development in all of its three spheres: economic growth, environmental integrity and social equity' (ISO, 2007).

Whilst the above work and statements bring promise, as yet, there exists no agreed or unified data model or information standards for SDGs reporting. It is also probably unrealistic to suggest, given the breadth and complexity of processes and institutions involved in SDG reporting and monitoring, that such a model could be developed, let alone implemented and maintained across all countries and sectors. That said, there is value in creating shared understandings about the value and role of shared data models, in terms of developing dialogue, if not shared language, between different domains, and country contexts. More pressingly for the SDGs, there is a need to better enable access and sharing of SDG-relevant datasets and measures. This is where interoperability, and hence standardisation, is imperative.

'Interoperability' is primarily used to describe issues in information systems and application scenarios. However, definitions are domain specific: IEEE Glossary define the term as (Geraci et al., 1991): *'the ability of two or more systems or components to exchange information and to use the information that has been exchanged'*. Interoperability assists in overcoming fragmented data production and dissemination, enabling the connection of databases within, and across sectors, organisations and countries.

Standards are also central to interoperability efforts, although, they reach beyond the domain of information technologies. Standards help to facilitate the adoption of good regulatory practice which in turn can help to protect communities and vulnerable people (ISO, 2007). In terms of the SDGs, example technical standards include for example, microgrids for wind energy generation systems (IEC 61400 i.e., SDG #7), and the ISO 50000 family of standards for energy management (i.e., SDG #13, #14, #15) and many more.

In terms of standardisation and interoperability actions undertaken by the UN, since 2018, effort has been made to develop a data hub for the SDGs, which is shown conceptually in (Fig. 1). The hub aims to support UN Member States in the collection of social and economic development goals. It is supported by national partnerships relating to data policies according to Esri (2018) and United Nations (2020). It is too soon to fully understand the success and impact of the hub, however, what is clear is that it is heavily reliant on the spatial dimension: the hub is enabled by web GIS and open geospatial standards, and in order to track the SDGs, geoinformation integrated with other economic, social and environmental data is essential. These initiatives further underline the importance of efforts to develop frameworks such as the Integrated Geospatial Information Management Framework (IGIF) (UN-GGIM, 2018) and the Framework for Effective Land Administration (FELA) (UN-GGIM, 2020) by the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM).

In the current Open SDG Data Hub, hosted by the United Nations Statistics Division (United Nations, 2020), data is collected by Member States: the SDGs are reported at a national level. The submitted data has to be able to be organised by gender and location: this is the general aim of the 2030 Agenda.

For this data disaggregation data standards are imperative and standards, as e.g. the LADM, can support this. LADM and STDM provide a standard set of terminology, classes and associations. Nevertheless, both models are flexible and can accommodate other attributes and associations and are extensible to allow inclusion and linkages of other situations and disciplines. The core classes of LADM are the spatial unit (LA_SpatialUnit, this can be a parcel), the party (LA_Party, this can be a natural or non-natural person) and the rights, responsibilities and restrictions (LA_RRR), which links the two other classes (ISO et al., 2012). Those core classes of the LADM can also be found in the STDM but are named differently as they focus on a different context, SpatialUnit, Party and SocialTenureRelationship (GLTN, 2014). The difference in terminology is based on the fact that the attributes in STDM describe legitimate rights instead of the statutory rights as in LADM (Zevenbergen et al., 2013). The SocialTenureRelationship is described through the continuum of land rights, as defined by (GLTN, 2014), to describe all people-to-land relationships. It can also be used to describe secondary use rights, overlapping rights or where people perceive their rights contradictory (GLTN, 2012).

The Social Tenure Domain Model (STDM) was initiated by the UN-Habitat Global Land Tool Network (GLTN) and was based on the Land Administration Domain Model (LADM). GLTN designed and developed

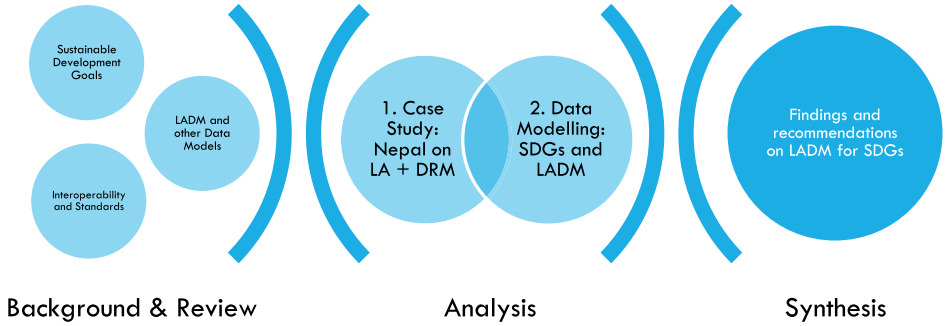

Fig. 2. Research Design.

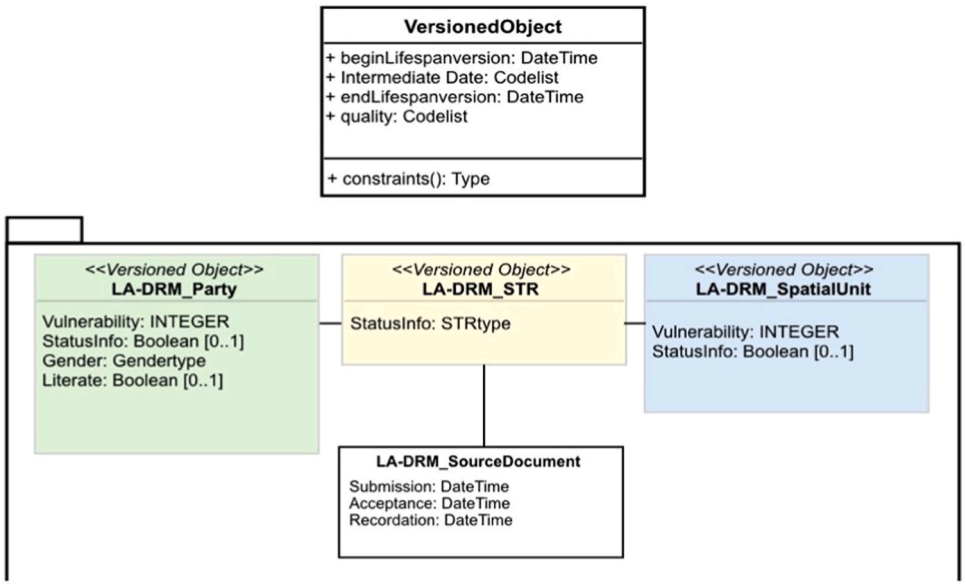

Fig. 3. The LA-DRM model as developed in (Unger et al., 2019a).

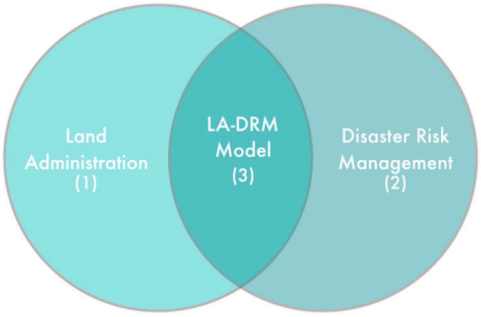

Fig. 4. LA and DRM fusion via LA-DRM.

the pro-poor and gender-sensitive land information management system in close cooperation with the University of Twente/ITC. The STDM (Antonio, 2011) can be used to support land administration of the poor in urban and rural areas, which can later also be linked or converted to the cadastral and land registry system. This is in support of the formal recognition of land rights and the integration of all available information on land rights into one system (GLTN, 2014).

Therefore, in sum - given the importance of: i) the spatial dimension in SDGs reporting; ii) land tenure security being foundational for the achievement of many of the SDGs; and iii) LADM (and STDM), a ready-made international standard, apparently providing a potentially role having wider application to other domains – examining whether and how this wider LADM application could support SDGs achievement appears worthy of examination.

3. Materials and methods

As disclosed, the aim of this work is to examine whether and how an existing international standard, such as LADM, could be extended and applied to support SDGs monitoring and achievement more broadly. Whilst full design work, backed by technical pilots and/or proofs of concept, would be the ideal means of exploring this potential, these activities demand significant resources and time, and given the urgency on supporting SDGs reporting, the pragmatist research paradigm suggests an alternate demonstration can provide similar value in the context of this research.

In this regard, a simpler more circumspect approach is used, made up of two independent activities (Fig. 2): i) illustration of potential LADM extension to another domain by examining an existing case study; ii) illustration of LADM flexibility through conceptual data modelling. The first activity can be considered comparative research, and the second can be considered design research (Rossiter, 1996). Whilst both are considered separate research undertakings, combined the results are suggested to provide a body of evidence, or a triangulation (McDougall, 2006), that can further confirm, or not, the idea that existing domain-specific data models can be extended to support the SDGs.

First, the case study work made use of reports and research findings

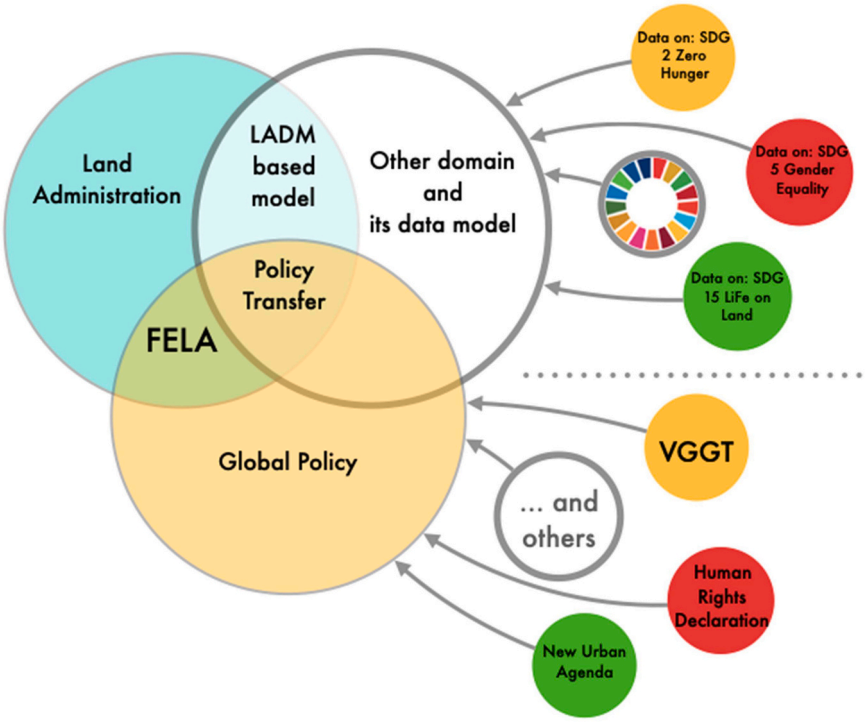

Fig. 5. Integration with other SDGs.

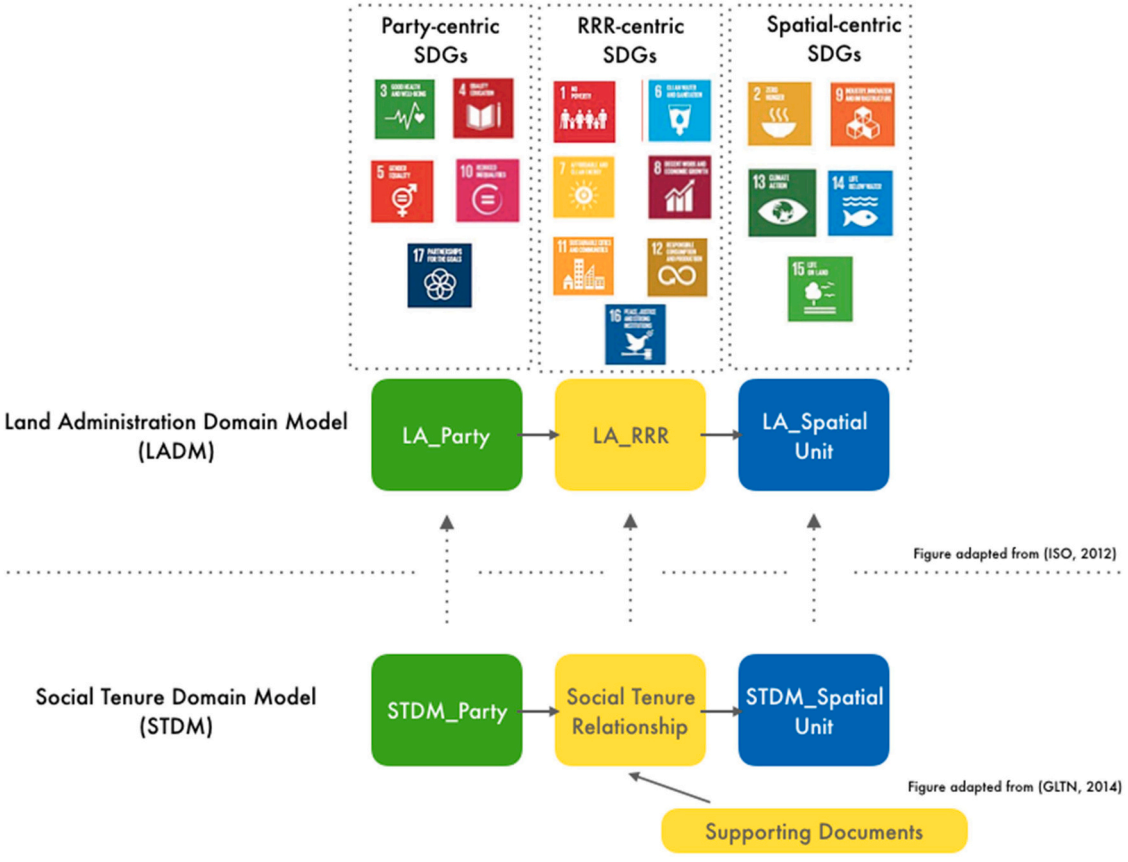

Fig. 6. LADM as a base to support the SDGs.

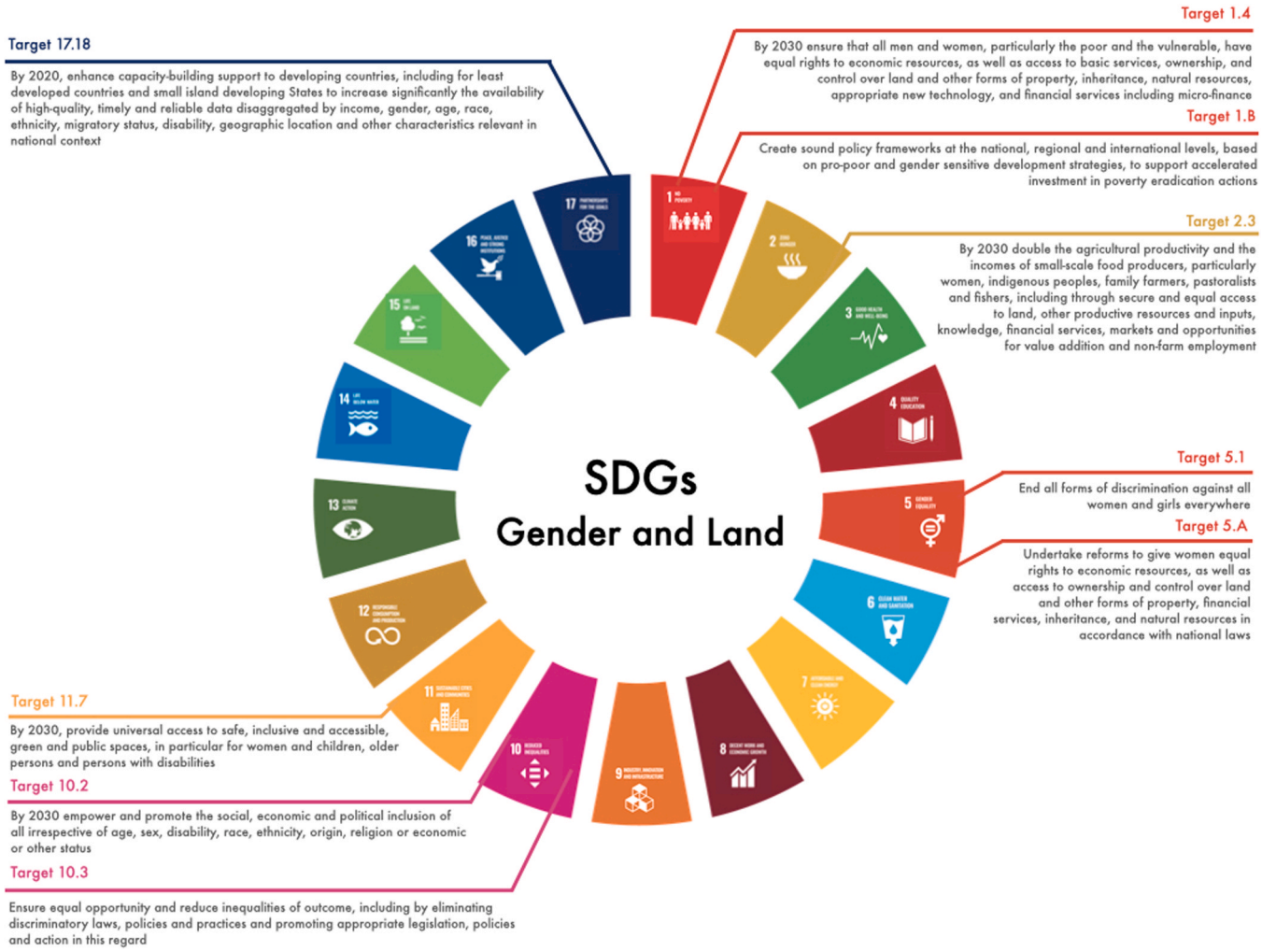

Fig. 7. SDGs Gender and Land *(*Unger, et al., 2020b*)*.

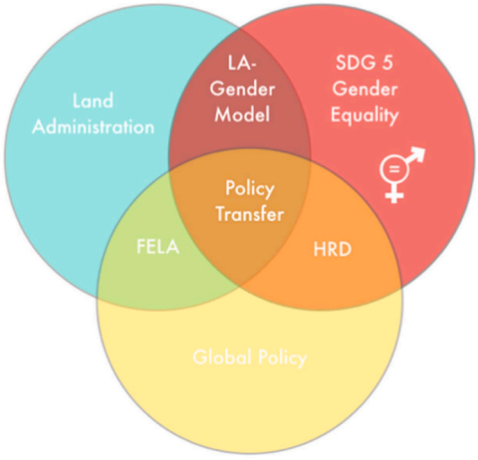

Fig. 8. LADM as a base to support SDG 5 'Gender Equality'.

undertaken previously by the authors with regards to data model development, for the dual purposes of land administration support and disaster risk management. The case data constitutes the academic papers from those studies and the underpinning research reports and raw data, all of which were accessible to the authors. This included field work and data analysis undertaken in Nepal. LADM was the basis for those works.

Second, the data modelling again made use of LADM, but also considered several of the SDGs and specific indicators as raw inputs for the conceptual modelling. It should be noted that full logical and physical data modelling exercise was outside the scope of this work: important was to demonstrate that the data requirements of the SDGs could be added to the LADM model.

The developed methodology, and the value of the subsequent findings and synthesis, is largely dependent by the concept of generalisability. (Baskerville and Lee, 1999) distinguish among different types of 'generalizing' in information systems research. First, 'generalisability' is said to refer to a theory's potential to possess the quality of generality, and 'generality' is identified as a characteristic of a theory at the end of the investigation. Within (Baskerville and Lee, 1999) several reasons are mentioned why an information systems researcher can claim generality for their research (or not). For example, what number of organisations are involved/sampled? Or is the theory is expected to hold in other instances that share the same or similar circumstances? It is further highlighted that acceptance of generality is imperative for the transfer of academic findings to professional practice, and this is key to the work at hand.

4. Case study: LA-DRM and Nepal

On the results of the first study, the development and pilot application of the LA-DRM data model, an extension of LADM, already provides one example of the ability to extend the data model to other domains

Table 1
LADM implications for Gender and Land.

SDG indicators on Gender and Land	Exemplary LADM implication
Indicator 1.4.1 Proportion of population living in households with access to basic services	In order to deliver information for this SDG indicator a connection to a database or information system storing information regarding the location of primary health care units, location of clean water access points, proper sanitation points, as well as location of basic education offices, and other basic services would be needed. This information could then be linked with the information delivered by LADM or any land administration system and queries could deliver the needed information for this indicator. For example::: How many people are owning land in an area with or without basic services? Or:: What is the greatest distance of a household to primary schools?
Indicator 1.4.2. Proportion of total adult population with secure tenure rights to land, with legally recognized documentation and who perceive their rights to land as secure, by sex and by type of tenure	In order to deliver information for this SDG indicator the request and demand for a LA_GenderType as justified in (Unger, et al., 2020b) is needed. A LA_GenderType could deliver the needed information for this indicator. For example::: How many women own land? Or:: How many properties are owned with equal rights between women and men?
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.	This indicator is not directly related to the LADM model or the information, which is stored in a land information system itself, but this indicator is directly linked to the policies and laws which are the legal basis on which systems are built on. Hence, if the legal framework is gender sensitive, the land administration system is reflecting this, and can deliver gender aggregated data.
Indicator 5.a.1 (a) Proportion of total agricultural population with ownership or secure rights over agricultural land, by sex; and (b) share of women among owners or rights-bearers of agricultural land, by type of tenure	In order to deliver information for this SDG indicator again the request and demand for a LA_GenderType as justified in (Unger, et al., 2020b) is needed. Further, in order to identify agricultural maybe a link to land use information would be needed. In order to deliver information for this indicator, the following example questions would need to be answered::: How many women and how many men own agricultural land? OR:: How many women and how many men have titles over their agricultural land? Etc.
Indicator 11.7.1 Average share of the built-up area of cities that is open space for public use for all, by sex, age and persons with disabilities	In order to deliver information for this SDG indicator a link of the LADM gender aggregated data to a database or information system for spatial planning, land use as well as a building register and census information would be needed. With this established links information such as::: How much area is open public space/owned by city/ municipality? or:: How much land is allocated to streets? or:: Who is owning land in built-up area?

(Unger et al., 2019a). The LA-DRM model aims to improve the management of land information when it comes to natural disaster contexts, and to find application at national, local and community level. The LA-DRM model was developed based on the LADM model and can be seen as an example on how to support linked domain-relevant information for the SDG indicators, related to location and land. Further, LA-DRM shows an example where a shared data model, the LA-DRM,

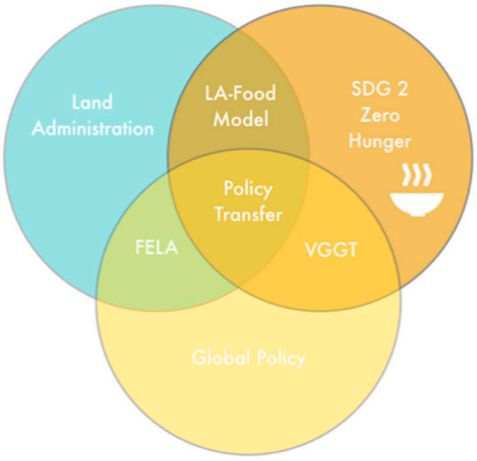

Fig. 9. LADM as a base to support SDG 2 'Zero Hunger'.

was created. However, the aim is to show that LADM has potential based on: i) interoperability aspects; and ii) the valuable and relevant data a complete land information system contains through linking with other domains to support the SDG reporting in various goals.

Unger et al. (2017) show that land issues arising during a disaster are often addressed with ad-hoc legislative design, and tool development in separated approaches for different domains. However, in order to provide administrative support to natural disaster management, and govern the impact of any disaster, basic questions concerning, 'What?' 'Where?' and 'How?' need to be answered, and this needs to be done in a clear, coherent and uniform way. The answers are needed in terms of specifically impacted individuals and communities, and also at an aggregated national level. Therefore, the need to access and share information via interoperability and standardisation measures demands further facilitation.

The above-mentioned concerns led to the recognition of the need to create a conceptual framework establishing a link between responsible LA and DRM (WCDRR, 2015). Subsequently, to create the link, a conceptual model, based on a global literature survey was developed (Unger et al., 2019a). The study showed no standard or tool could be found which supported both fields. Therefore, the developed LA-DRM model (Fig. 3) aimed at improving the management of land information when in the context of natural disasters.

The introduced LA-DRM model was based on the LADM/STDM concept, using the same classes but with additional attributes describing the scale of vulnerability, hazard and exposure. The development of LA-DRM was based on literature review, expert group discussions and field experiences from Nepal. Since the LA-DRM was based on the LADM/STDM, all the requirements as defined in (Lemmen et al., 2015) were considered to be valid. Various requirements were adapted, and some additional ones were added as presented in Unger et al. (2019a).

The LA-DRM model shows that it is possible to link LA and DRM, at the level of data capture, and that the occurrence of disasters is the most evident reason to include all people-to-land relationships in any LA system. Further, the potential of the LA-DRM model in each of the DRM phases was described and graphically illustrated in Unger et al. (2019a) to emphasise this linkage.

The conceptual data model development delivered a tool applicable in the field for assessing impact on tenure security and recording disaster risk elements, such as vulnerability and exposure. The model was tested in the post-earthquake setting of Nepal (Unger et al., 2019b). This case study identified that vulnerable or at-risk groups are children, elderly, persons with disabilities, women, the poor and marginalized and especially people affected by tenure insecurity and hence could not receive reconstruction grants. The conditions for securing reconstruction grants were (1) a citizenship certificate, (2) an identity document, and (3) proof

of landownership. Many earthquake victims could not meet one or more of these pre-conditions and were unable to access reconstruction grants. LA-DRM was used to map these vulnerable groups based on their needs, priorities and marginalization. The main purpose of this was to identify the level of tenure security; the scale of vulnerability, exposure and hazard; their grant status; basic household economy; and all related to the people-to-land relationship. Various queries could be generated with the LA-DRM model. The results and analysis were then further used to integrate and implement interventions for planning, response and relief processes.

The research highlighted that DRM policies have to be redirected towards tenure security, poverty and vulnerability reduction, instead of only short-term compensation, resettlement and relief responses. The importance of documenting all people-to-land relationships was proven in order to prepare, mitigate and respond to natural disasters. Further results of Unger et al. (2019b) showed that through the documentation of all people-to-land relationships, efficient and effective land use planning can further mitigate disaster risks: backups of all documents, stored safe, can be used for an inclusive, participatory and transparent resettlement process. Through the application of the LA-DRM model it was expected that a complete LA system would create opportunities to mitigate and prepare for disasters. This case study further validated a strong link between LA and DRM and the benefits of an integrated information system approach.

In summary, the above-work shows it is possible to theoretically, conceptually, and practically harmonize the domains of LA and DRM, via LADM (Fig. 4) – both implicit domains linked to the SDGs - using constructs and terminology common to both domains and by creating a shared viewpoint. Unger's et al. (2019a) LA-DRM model is aligned to the internationally agreed LADM standard (Lemmen et al., 2015).

Whilst (Unger et al., 2019b) successfully demonstrated the benefits of actual tool linkage within LA and DRM for a specific case, the approach of utilising LADM and share its data with other domains appears to hold potential with respect to SDGs reporting and monitoring, as now examined.

5. Modelling: generalising LADM for SDGs

As already shown, responsible LA can be directly linked and even integrated in DRM processes. Moreover, this integration and especially linkage with the spatial dimension, demands a more prominent role of standardisation efforts in the land domain, such as LADM. Especially now, the interrelationship of LA with various other disciplines reflected in the SDGs becomes visible: LA is intrinsic to other fields of study including for example, poverty reduction, food security, and gender equality.

Accordingly, Fig. 5 could be hypothetically adapted for various other LA related disciplines/domains or SDGs. That is, a standardised underlying data model, such as the LADM, combined with an linked data capturing mechanism, could enable reporting and monitoring (Fig. 5). Such standardised data models can support interoperability and the overall idea of 'collect once – use multiple times' but can also identify coordination problems and support solutions. Conversely, lessons from the application to other domains, can support the update and development of the LADM[1] itself (Lemmen, et al., 2019) and policy transfer concepts as developed in Unger et al. (2020a).

Getting more specific, modelling of the basic classes of LADM /STDM (GLTN, 2014) towards the SDGs is shown in Fig. 6. All the SDGs serve different purposes and hence have different targets and indicators. Nevertheless, the LADM/STDM basic classes could be matched with the SDGs and categorized into Party-centric, RRR-centric (Rights, Restrictions and Responsibilities), and Spatial-centric SDGs. The aim of this figure is not to divide the SDGs, but instead to highlight how essential a flexible basic data model, such as LADM, is in order to link its information with other domains and so support the reporting and monitoring of the SDGs. It can act as a foundation model supporting the delivery of the information for achievement of their targets and indicators for monitoring. A holistic approach strengthens the demand for, and also the possibilities of, interlinkages with the 2030 Agenda for Sustainable Development and its 5Ps (People, Planet, Prosperity, Peace and Partnership) (UN, 2015) and the domain of LA.

Focusing on the specific case of SDG 5 Gender Equality, as presented in Fig. 7 and Fig. 8 SDG 5 'Gender Equality' is closely linked to the Human Rights Declaration (HRD)[2] and other policies such as for example the Convention on the Elimination of all forms of discrimination against women and the United Nations Declaration on the rights of indigenous peoples (United Nations, 2007). Analysing the indicators on Gender and Land through an investigation of global rules and regulations, and policies, helps to define requirements for LADM. On the other hand LADM classes and attributes can be adapted to ensure LADM and the linked LA processes are i) gender sensitive and inclusive and ii) delivering tenure information which is gender aggregated. The generated and aggregated information, or if needed an adapted LADM model, as named here for example 'LA-Gender Model', can then be used to deliver data for the requested SDG targets and indicators. On this, an analysis of these Gender and Land related targets was conducted in Unger et al. (2020b).[3]

Based on this analysis, five examples further explain the concept of LADM for sustainable development (Table 1). The table describes the SDG indicators on gender and land and explains which implications this indicator could mean for LADM and which queries could be made in order to report and monitor towards this SDG indicator.

The result of the investigation could also be that no changes in the LADM model are needed. Nevertheless, the modelling assessment, and also the assessment of whether or not the model is aligned with those global policies can be done using the policy transfer processes described in Unger et al. (2020a). Hence, similar to the LA and DRM case (Fig. 3), an integrated approach for SDG 5 and LADM can be conceptually shown in Fig. 8. Based on Fig. 5, Gender Equality (SDG 5) is seen as a party-centric SDG, since most of the additional required data or if necessary required changes in LADM are suspected by the researchers to be in the LA_Party class. One of the changes could be the introduction of a gender attribute or an additional distinction of the LA_GroupPartyType, as investigated in Unger et al. (2020b).

Another example can be generated based on SDG 2 – Zero Hunger (Fig. 9). As a global policy guideline, the VGGTs (FAO, 2012) can be investigated. Within the VGGTs, and other literature, land readjustment and consolidation, are some of the measures to address food security. Hence, LADM must be supportive and deliver information or must be able to integrate or link to data which is relevant towards the processes of land readjustment and land consolidation, in order to support SDG 2. SDG 2 – Zero Hunger was categorised as a spatial-centric SDG, though the researchers are aware that especially when it comes to food security, clearly defined rights, restriction and responsibilities (RRR) are imperative.

6. Conclusions and recommendations

This paper shows the potential and added value of an integrated data modelling approach, with regards to responsible LA and its application to other domains, for example DRM, food security, and gender equality, and the SDGs more broadly. This was done through using literature review, case exploration, modelling, and research generalisation concepts. In this vein, LADM was shown to have direct relevance and

[1] June '19 OGC TC/PC Meetings - Leuven, Belgium, https://www.opengeospatial.org/events/1906tc

[2] https://www.un.org/en/universal-declaration-human-rights/

[3] currently under review

application to several domains, at least at the level of data standardisation and interoperability.

Future research should focus on applying a similar holistic logic on the other SDGs. Additionally, future work could focus on applying, testing and hence further developing strategies to link data models, which are based on international recognised standards. Also, more work is needed in regard to the disaggregation of the reported information which is published at the Open SDG data hub. Reporting and monitoring mechanisms within a location context of the SDGs can be achieved through data disaggregation and integration with other domains and disciplines.

However, some caution is also needed: standardisation, through a conceptual data model, which is based on an internationally agreed standard, as the LADM, creates opportunities but can also lead to dangers. Standards support interoperability and hence can be used by machine learning mechanisms. Therefore, future research could also address these dangers, where personal data collected may be manipulated and linked to other data, and hence used for less benevolent purposes. Another potential concern is the data model driving the SDGs monitoring and evaluation work, and not vice versa. The data model should support the process, not drive it (e.g. force the adaption of indicators, for example).

Nevertheless, the need for open standards and open data to enhance developments and support informed and transparent decision-making processes remains clear. Moreover, based on this work, it is revealed that there is no need to develop entirely new data models: instead using what is already available and building upon those should always be the focus, in the first instance. Overall, initiatives surrounding SDGs reporting, via data standards and hubs, and identifying the importance of location and geospatial information, is seen overall as a positive for society, economies, and environmental issues.

CRediT authorship contribution statement

Eva-Maria Unger: Conceptualization, Methodology, Validation, Investigation, Writing - original draft, Writing - review & editing, Visualization. **Rohan Bennett:** Conceptualization, Methodology, Validation, Investigation, Writing - original draft, Writing - review & editing, Visualization, Supervision. **Christiaan Lemmen**: Conceptualization, Writing - original draft, Writing - review & editing, Supervision. **Jaap Zevenbergen:** Conceptualization, Writing - review & editing, Supervision.

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