Towards a New Working Item Proposal for Edition II of LADM

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SUMMARY

This paper presents the first and incomplete draft text for the revision of IS 19152:2012 'Geographic information — Land Administration Domain Model (LADM)' within ISO TC211 in the form of a New Working Item Proposal (NWIP). This 'two-page NWIP' text aims to describe the scope of proposed project to revise, and also provides the purpose and justification behind this revision of LADM. The International Federation of Surveyors (FIG) also submitted to ISO the NWIP for the current version of LADM (IS 19152:2012). As for the revision the ambition is now to go beyond just a conceptual model by providing steps towards implementations (e.g. more specific profiles, technical model in various encodings, etc.), it is the intention that the Open Geospatial Consortium, Inc. (OGC) is heavily involved in the revision and that the result is a joint ISO/OGC standard. For this purpose the recent draft OGC White Paper is added as Appendix 1 to this paper to provide more detail background information.

It is further noted that the complete NWIP for Edition II of LADM also 'Preparatory work' should be attached; e.g. a draft of the new version of the standard. In the case of the revised LADM standard of course this is based on the IS 19152:2012, but will contain also contain collected materials from the LADM2017 and LADM2018 workshop.

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1. INTRODUCTION

This New Working Item Proposal provides an overview of needs and requirements discussed international experts during LADM Workshops in Delft, The Netherlands, in March 2017 and in Zagreb, Croatia in April 2018. The first edition of LADM should be upwards compatible with future editions. Future editions may have an extended scope. LADM improvements and extensions are needed – as well as LADM process models.

2. SCOPE

A proposal to extend the scope of LADM with a fiscal perspective is available (Çağdaş et al, 2016, Çağdaş et al, 2017).This proposal provides a data model that could be used to construct information systems for immovable property valuation and taxation, and offer a data exchange option. The proposal provides a common basis for governments to direct the development of local and national databases, and for the private sector to develop information technology products.

The Global Land Indicators Initiative, see UN Habitat/GLTN, 2017 and also UN ECOSOC and African Union, 2016, seeks to derive a list of globally comparable harmonized land indicators, using existing monitoring mechanisms and data collection methods as a foundation. Internationally agreed standards will be key alongside agreed global concepts and evidence-based approaches. There is need for a foundation of a Land Administration Performance Index – which is possible linked to existing global frameworks or initiatives.

Legal space and legal objects have its own geometry which is in many cases not (or not completely) equal to physical space and physical objects. Legal space should be linked to physical objects – by ids or re-use of descriptions of space. GML and CityGML offer options in this respect. The users of the indoor spaces create a relationship with the space depending on the type of the building and the function of the spaces. Applying LADM allows assigning rights, restrictions, and responsibilities to indoor spaces, which indicates the accessible spaces for each type of user. A IndoorGML-LADM model is one example of linking physical and legal objects. A normative reference to IHO S121 (Marine Limits and Boundaries) based on the LADM principles needs to be included in ISO 19152.

Spatial planning/zoning with legal implications. In principle this is a matter of coding zones in code tables (based on the local situations). It further implies integration of spatial planning and land administration environment. Re-use of zones from spatial planning into restrictions to land rights should be possible. Other legal spaces are related to mining, archaeology, utilities.

3. IMPROVEMENTS

For the domain of land administration, the localization issue extends from language names to the various organisations and institutions dealing with interests in land. Paasch et al (2015), propose code lists as a mean of internationalization by which the classes of the LADM may be related to the jurisdiction concerned. The issue of code lists has been addressed by the OGC as well, namely in terms of the document 17-050r1 Code List Manifesto. Meta data and tenure atlases are relevant in this context. Tenure atlases provide overview on tenure systems and the level of recognition. This may include areas without land markets and nature preservation etc.

There is a model for representation of legal space with a datatype allowing the representation of volumes that are not completely closed. More functionality is required for a complete partition of space: more explicit 3D+time profiles. An extended survey model and legal model is needed. This implies adjustments from field observations to the spatial database and the generation of quality labels. Encodings/technical models concern the further integration of LADM with existing standards: BIM/IFC, GML, CityGML, LandXML, LandInfra, IndoorGML, RDF/linked data, GeoJSON. BIM is very important in order to establish a link between BIM and land administration in relation to spatial planning and lifecycles of buildings. Open data is about Coding of Rights, Right holders, Spatial Unit Types, etc. See Informative Annex J of (ISO 19152, 2012) – W3C.

4. PROCESS MODELS

Cadastral map updating includes adjustments and transformations of field observations (collected are different moments in time and with different survey instruments or use of imagery from different sources) to the spatial database. Management of areas is needed – there may be more then one area to be maintained for the same spatial unit – the legal area and the accurate area as calculated in the cadastral GIS. Implementation of tolerances to manage the differences should be flexible and purpose related. Results of subdivisions of spatial units may need to be shared with others systems. This includes results of readjustments and land consolidation.

Blockchain technology in transaction processes could be very well applicable for transactions in land administration.
Conversion of social tenure to legal tenure is a process that may require different levels (layers) with related attributes. The same is valid for geometric quality improvements of the cadastral map.

A new class representing processes may be defined: a specialisation of the class representing sources – thereby creating a connection between the classes of workflow management module and LADM classes.

Processes can be organized on the basis of use of electronic signatures in case of applications and information requests with public and private keys and encryption/decryption. Provision of

information to data collectors for initial data collection or maintenance is a specific but very important process (task management, logistics).

New approaches in Land Administration include Volunteered Land Administration and Crowdsourcing. It is possible that right holders and communities collect and maintain their own data with a certain level of professional support for quality insurance etc. Participatory surveying is possible with GPS. Conversion from social tenure to legal tenure may require professional support – but it is easy to make this process complex and complex to make it easy. The Publication of parties, related rights and spatial units also via global services (as may be Google, Virtual Earth and Open Street Map and many others).

There will be a need for considerably more integration across the various national data and information systems and platforms in order to leverage the most effective data and analysis for evidence-based policy formulation and decision making. Image-based acquisition of cadastral boundaries needs access to huge image libraries – including historical imagery – to support large-scale implementations.

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APPENDIX 1 Draft OGC White Paper on Land Administration
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OGC White Paper https://portal.opengeospatial.org/files/?artifact_id=77835&version=2
Note: The OGC Land Admin DWG vote still to be done at this moment in time.

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OGC White Paper on Land Administration

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i. Abstract

This white paper creates overview and proposes actions needed for design and develop implementation standards in the land administration domain. A close cooperation between OGC and ISO is expected to accelerate those developments.

A huge task is waiting: the establishment of land rights for all: young and old, rich and poor, male and female. Data on many millions of parcels, spatial units, (use-) rights, persons and parties have to be collected, linked, maintained and published. Land administration systems should be designed for maintenance of the dynamic relations between people and land. Existing land administrations require extensions - such as 3D and 4D functionality and datasets; blockchain for transparent transactions, generic processes and integration with remote sensing. And: processes to support conversion from social to legal tenure.

A broad range of geospatial technologies and applications is available. They range from satellite and drone imaging and mapping, to geodesy, precise positioning, geo-information science, cartography, spatial data infrastructure and many surveying sub-disciplines. The scientific and professional disciplines in the geo spatial community design, develop and apply those technologies. Apart from this technical component a land administration has also a social and legal component. This makes land administration an arena where, apart from the geo-spatial community, many different scientific and professional disciplines meet. Depending on phase stage of development and the level of societal acceptance of the land administration those involved disciplines may be different.

1. Introduction

Land Administration is defined as the processes of recording and disseminating information about the ownership, value and use of land and its associated resources. Land administration further includes restrictions and responsibilities related to rights, land value, land use and impact of development processes (UNECE, 1996).

Land administration systems are not just 'handling geographic information', as they represent a lawfully meaningful relationship amongst parties (natural and non-natural persons, companies, governmental bodies etc.), and between people and land. There is a call for recognition and inclusion of legitimate tenure rights – as customary land rights or informal land rights. There is a global call for conversion of social tenure to legal tenure – see goal 1.4 in the Sustainable Development Goals.

At the 'other side of the spectrum' the management of complex urban environments is asking more and more for representations of rights in 3D. The complexity of managing these issues implies that stakeholders from different disciplines need to cooperate in the development and operationalisation of land administration standards.

Land administration can be title or deed based in case of property rights. In case the state owns the land occupancy rights can be managed. Initial acquisition can be organised based on sporadic and systematic initial data acquisition. People to land relationships are dynamic and require maintenance. Land Administration Systems should be designed for maintenance purposes from the very beginning.

Maintenance and updating may be regular and continuous based on transactions on land rights or may be applied based on time intervals. Systems may be completely or partly analogue or digital. In many countries legal documents are paper based. Transactions may be based on the use of digital signatures. Organisation operate often under distributed responsibilities. Organisations often have a long history and data are collected over a long time – with different methodologies, archive approaches and technologies. Analogue data are sensitive data and it is complex to organise a reliable backup.

Methods and land tools develop rapidly, supported by private companies, modern technology and new information and communication possibilities. Further steps are needed to operationalise those methods and tools, at scale (Enemark et al., 2016). Innovative thinking coupled with quickly maturing, scalable approaches is needed in many countries in order to create full coverage in land administration. Support is needed by world-leading private companies, modern geospatial technologies and a new professional mindset, the provision of global land administration that supports good land governance appears to be a feasible objective within the current generation – this would be in alignment with the UN Sustainable Development Goals – SDGs (UN 2015).

This paper gives an overview overview of land administration standardisation in section 2. Context of development of land administration is given in section 3. Needs and requirement are in section 4, followed by an overview of proposed actions in section 5. The paper ends with concluding remarks in section 6.

2. Land administration and ongoing standardisation

The Land Administration Domain Model (LADM) has been developed by ISO TC 211 on Geographic Information. This development was initiated by the International Federation of Surveyors (FIG). It is referred to as ISO 19152 (ISO, 2012). CEN 287 adopted the standard. This knowledge domain specific standard captures the semantics of the domain. It provides a shared ontology, defining a terminology for land administration. The LADM covers basic information related to components of land administration: land administration includes water and elements above and below the earth's surface, and people. Those components concern: party related data; data on Rights, Restrictions and Responsibilities (RRRs) and the basic administrative units where RRRs apply to; data on spatial units and on surveying and topology/geometry. LADM includes the Social Tenure Domain Model (STDM).

The data sets in those components are represented in Unified Modelling Language (UML) packages and class diagrams. All data in a land administration are supposed to be documented in (authentic) source documents. LADM is capable of supporting the progressive improvement of land administration. LADM can potentially be used to support organisational integration, for example, between often disparate land registry and cadastral agencies. LADM can help to reconcile superfluous government databases and reduce the large amount of data redundancy that currently exists.

LADM can be integrated with other geo-information standards - e.g. to link legal spaces to their physical ‘counterpart’ represented in BIM/IFC, GML, CityGML, LandXML, LandInfra, IndoorGML, RDF/linked data, GeoJSON. LADM code lists could provide the basis for establishing a complete catalogue of global land people relationships. Registries would be needed for managing the content: code list values and their definitions.

The members of the Open Geospatial Consortium (OGC) drafted a charter for a Land Administration Domain Working Group (OGC, 2016). This charter describes how to improve the effectiveness and

efficiency of land administration systems by optimising the use of OGC and complementary open standards. Land administration activities in all countries can benefit from improved interoperability using open standards. Improved interoperability contributes to reduced deployment time, lower system lifecycle costs, improved flexibility and scalability, improved choice from the IT marketplace, and improved ability to share, exchange and integrate information related to land administration. While there are some standards describing elements of an administrative system, such as in LADM, there might be gaps in the way that they incorporate geographic descriptions of land records, and/or inadequate rules for defining and describing the quality of the records. There might be governance barriers in adopting the standards as well.

The OGC Land Administration Domain Working Group aims to assess the existing standards and address any gaps and barriers it finds. There is a challenge for countries on how to implement the rich model. There is a need for good practices, processes, implementation guides, expertise from past implementation.

The UN Economic and Social Council (ECOSOC), identified the need to take action to strengthen international cooperation in the area of global geospatial information management by establishing the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM). Under UN GGIM an expert group on land administration and management has been established, which focuses on addressing sustainable governance, data management and the adoption of institutional frameworks and technology in relation to land administration and management systems, as well as their linkages to the relevant aspects of the SDGs. The UN-GGIM encouraged the expert group to address the issue of fit-for-purpose land and geospatial information required to support effective and efficient land administration and management (including standards) in order to address the need to secure land and property rights for all1.

Operationalisation of LADM enables providers of survey instruments, service providers for land administration, suppliers of Geographical Information Systems (GIS), Document Management Systems (DMS) and Database Management Systems (DBMS) to develop products, services and applications. And in turn this will enable land registry and cadastral organisations to use these components to design, develop, implement and maintain systems in an even more efficient way.

3. Context of developments

This section provides overview and context of developments to be used for analyses and setting of needs and requirements for data acquisition, maintenance and publication. Requirements range from development of 3D cadastre (including underground utilities and infrastructure) till the initial set up of a land administration or initial data collection.

Data maintenance is crucial: people to land relationships are dynamic. Some interoperability and outputs are discussed and public private partnerships PPPs. Those PPPs can be organised in a technical settings as available today.

[1] See http://ggim.un.org/UN-EG-LAM/

3.1 Data collection

Ongoing urbanisation and increasing complexity of infrastructures and densely built-up areas require a proper recording and registration of the legal status which can only be provided to an limited extent by the existing 2D cadastral systems. The registration of the legal status is getting complex in 2D. 3D, including indoor modelling, is required to capture the whole legal and spatial dimension, which further includes the marine environment.
In cases where values of land is higher or an intensive land use is existing, conventional field surveys using high-precision instruments (GPS, Total Stations, Laser scans) are deployed.

Different types of survey approaches require support in adjustments of new to existing spatial cadastral data combined with the storage of the original filed observations. The required software for adjustments is often integrated in the survey instruments – but it should also be available during cadastral mapping – e.g. with a tablet in the field. In all cases there should be options to include rights and right holders with related attributes. Adjustments of field observations to existing cadastral spatial data could be included in cadastral GIS. Surveys are also needed in support to quality improvement of cadastral data.

The Fit-For-Purpose approach (FIG/World Bank, 2015, UN-Habitat, 2016) argues for cost-effective, time-efficient, transparent, scalable and participatory – incl. participatory surveying, Volunteered Land Administration and Crowdsourcing. In many situations, it is sufficient, to identify visual boundaries in the field using imagery. Land administration systems are simple at the start and can improve over time whenever necessary or relevant. It is a dynamic process: purposes evolve in regards to countries/areas, technology etc., thus administration as well. Such approach must be gender sensitive, transparent and highly participatory. The approach is affirmed in the Addis-Ababa Declaration 'Geospatial Information Management towards Good land Governance for the 2030 Agenda', (UN-GGIM, 2016). Implementation of the Fit-For-Purpose approach requires flexibility from standards and a good model for data description using meta data – as the LADM. LADM supports the continuum of land rights (management of different tenures in one environment) and a continuum of approaches in data acquisition and recordation and many different representations of spatial units (point-based, line-based, polygons-based and volume based) and parties (from groups to individual and non-natural persons). Complete point based approaches with identified monuments or beacons (or wooden pegs) are time consuming and complex.

Using App and cloud technology collected field data can be transmitted from a mobile directly to a cloud-based GIS environment, enabling everyone to follow the process remotely. The field survey is, for example, about creating an overview of all existing people-land relationships, including formal (legal) ownership and informal (social) land use and also overlapping claims. Owners or claimants are invited to walk the perimeters of their land parcels and to point to the vertex points of the boundaries themselves using a GPS antenna. An grassroots surveyor records the observations with an App installed on a mobile or tablet. Satellite imagery of the area is displayed on the screen of the mobile device. Data collection is done in an integrated way: the perimeter is stored as a closed polygon together with the claimed type of right combined with a photo of the face of the owner or claimant and a photo of the owner's or claimant's ID. A preliminary identifier is used as linking key. The GPS antenna may be handheld-low-accuracy. In this way the walked perimeters identify a boundary from sides, from two spatial units. If those are within tolerance it demonstrates agreement. The approach implies that neighbours do not have to be in the field at the same time – because this is related to serious logistic problems - availability in the field of both neighbours per boundary is complex to organise. The approach can be done in analogue way too. Digital pens may be used in that case. This

approach can be organised as participatory survey – where the right holders hold the antenna and point the vertex points and a grassroot surveyor (trained by a professional) collects the data in the App – with a very simple user interface. In this case the professional surveyor is the organiser, the person who creates awareness, organises the data acquisition, accepts the data and manages quality assurance. GIS is needed to handle collected data – calculating averages in boundary observations (which is complex – not the same points are observed from two sides), identification of objects, area calculation and public inspection). During a public inspection of collected data the agreement on boundaries can be confirmed – and the boundary may be visualised as "green" (agreed) boundary.

It is crucial to get an overview of areas under dispute and to collect the geometry of the disputed area. 'Dispute holders' need to 'agree' on the area and location of the dispute. During the adjudication process in the field, disputes may lead to the creation of overlaps between polygons. In that case, those overlaps are mapped and the corresponding authorities know the exact location of which type of land-related conflict. After field data collection, the data must be checked for completeness and prepared for public inspection.

Imagery can be collected from satellites, traditional aircraft or unmanned aerial vehicles (UAVs). Integration of knowledge and expertise from Remote Sensing in the Land Administration Domain is important and needed.

Automated feature extraction may be applied to boundaries of plots bounded by topographic features instead of the plots themselves. If extracted features are visualised on printed or screen displayed imagery they can be used to identify features as being identical to cadastral boundaries or not. Extracted features may be printed. Feature extraction may be helpful in estimating the number of parcels or spatial units that can be expected in project areas. It is often unknown what can be expected in the field.

In general, fixing boundaries should be avoided in the preliminary stages of development of land administration. Demarcation with monuments or beacons takes a substantial part of the (grassroot) surveyor's time. If demarcation is an absolute legal requirement, people could place the beacons themselves. Otherwise, it is a good idea to explore modern demarcation methods – smart markers could provide a good alternative. Modern markers like the traceable 3D radio frequency identification (RFID) markers can be detected and identified from a distance of several metres using a simple smartphone.

Data acquisition for millions of spatial units – based on evidence from the field in participatory approaches – is an enormous operation. Millions of polygons, lines and points are to be observed in reality and need to be linked to formal and informal holders of real rights and/or use rights. The organisation of this process requires millions of spatial support in logistics and case management based on geographic information. During field work a check on the completeness of the data acquisition needs to be performed – in an easy way. Tools, transport, paper, imagery, awareness campaigns, local support from local authorities (if needed in co-management with traditional authorities), grass root data collectors combined with professional expertise has to be organised at the right place and time.

3.2 Processes, maintenance and transactions

Updates and changes may concern parties and its attributes, rights, restrictions and responsibilities and related attributes, basis administrative units and related attributes and spatial units and related attributes. Common transactions are buying and selling, establishment of mortgage or rights (for example encumbrance, usufruct, but may be also tenancy). A very specific transaction is the inclusion of the result of spatial planning – e.g. a land consolidation or land readjustment.
More generic process-related modules (see Stubkjaer, et al., 2007) in data acquisition and data handling and also maintenance and publication are needed. Standardisation can also make it easier to monitor the progress of global indicators relating to land tenure security. Process information is information on who has to do what in approving the transaction. LADM has roles already included as well a series of dates as interaction to processes – but the LADM Edition I does not include Land Administration processes for initial data acquisition, data maintenance and data publication.

Cadastral data maintenance can be 'programme driven' (systematic) or 'sporadic'. Programme driven means a complete and systematic new acquisition after initial data acquisition or an earlier maintenance effort. Sporadic means case by case in a 'transaction driven' way and relates to transactions in the land market (buying/selling, establishment of mortgage, etc.). Transactions require source documents providing the basis for changing and updating the data in the database – from one consistent state to another. Attributes in all classes can be subject to change.

The blockchain is a secure mechanism to handle and store transactions in a distributed ledger environment. Once a transaction has taken place it cannot be altered or erased from existence. A transaction is irreversible. An additional advantage is that not only the transaction itself, but also the history of transactions is safely captured, making the data immutable and hence providing trust by definition. Blockchain is also known as the 'distributed ledger'; it is the database that provides proof of who owns what at any given time, and it is publicly available and publicly maintained. A blockchain is transparent. That means: everyone who would like to see the transactions, is able to do so and verify the transaction. This makes the process of value exchange visible, so normal people can see any injustice. This development requires co-operation with ICO TC 307 on Blockchain. FIG is involved here. Smart contracts are contracts whose terms are recorded in a computer language instead of legal language. Smart contracts can be automatically executed by a computing system, such as a suitable distributed ledger system. The smart contract is the layer that fully utilises the potential of blockchain technology. Smart contracts contain the computer code that executes the contract.

Surveyors and geo-professionals focus on geometric accuracy, and this focus should result in quality labels identifying the relative and absolute accuracy of geometric data. This is relevant for adjustment later on and the integration of data from different sources collected with different instruments and tools in different approaches. But land administration is not only about geometric data. Talking about quality in Land Administration means not only talking about geometric accuracy, but also about 'linking' polygons (spatial units) and people (right-holders). Functionalities should be combined in one single device, i.e. linking functionalities for image-based data acquisition to handheld GPS, biometric data (fingerprint identification and facial recognition) and voice/video recording in support of object identification. Such devices could also be useful for inspections, for fieldwork related to building and construction permits, for cadastral maintenance, etc. Land data collected on many devices could deliver results in formats based on operational standards.

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

3.3 Interoperability and Outputs

Interoperability, data sharing and data integration is needed in development of land administration.

External links to other databases (supporting information infrastructure type of deployment), e.g. addresses, population register, business register, building register, utilities register, etc, are needed.

This includes access to libraries with cloud free compositions of imagery as produced on large scale with remote sensing technologies; approaches in initial data acquisition, methods in public review/inspection, checks on complete coverage. Data sharing means the data is collected once and used many times through establishing linkages with for example SDIs. Duplicative efforts in data collection and maintenance can be avoided. Data has to be 'kept at the source'.

Services are needed in support to data collection and maintenance. Services may be used to download available data to tables and to upload newly collected data. Downloading is needed because in many areas internet is not reliable yet. Services may support declaration of land rights on line by the rightholders themselves. Quality assurance procedures are required here. Also for maintenance services can be developed. Further applications may be in reporting land disputes and conflicts, requests for information, publication of land data, provision of products and services, land right formalisation, map renovation and quality improvement, and digital archiving.

A fiscal registry or database is supposed to record legal, physical, geometric, economic, and environmental characteristics of the property units, which are subject to immovable property valuation and taxation. A Land Administration infrastructure is required to link fiscal registries with other public registries (e.g., cadastre, land registry, building and dwelling registries).

3.4 Public-Private Partnership

While most of the developing economies are trying to establish land administration systems, some developed jurisdictions are undergoing significant change in terms of their land administration systems. The New South Wales state government in Australia privatised the operation of its land registry in 2016. The South Australian state government also privatised it land registry earlier in 2017. Now, Victorians await on whether that their lawmakers will follow suit.

While rare, privately operated land registries do exist elsewhere. A private operator administers the buying, selling and subdivision of properties in the Canadian provinces of Ontario and Manitoba. In other jurisdictions, there have been unsuccessful privatisation attempts. In 2013, the Canadian province of Alberta's Real Estate Council concluded that a proposal to privatise the title office was not in the public interest. And last year, the province of Nova Scotia assessed the prospect of a privatised titling office and concluded there would be no considerable gain from it. The UK Conservative

government in 2016 also examined this idea but did not go ahead with privatisation. This was primarily due to a lack of support from the property industry and a fear of public backlash.

There are risks and opportunities PPP based land registries bring including increased fees, a natural monopoly, banks requiring title insurance for purchasing properties, risks to the integrity of land registration processes and property information, depreciating existing skillsets in the title offices that are hard to source and the prospect of jobs moving elsewhere and even overseas.

At the same time, PPP based land administration provides an opportunity to harness technologies that transform these into faster and more automated processes while removing intermediary fees and reducing red tape. Using technologies like blockchain, titles and other documents can be encrypted and protected in digital transactions. This challenges the need for lawyers to check documents, financial institutions to prove money exchange, insurance companies to back your title, and title offices to register the transactions. Consumer-grade technologies such as drones, 3D scanners and smartphones also make it easier for the public to collect land information. This will challenge regulated professions such as land surveying. These professions need to be rethought in a technology-driven society where land data collection becomes accessible to everyone (Kalantari and Jeffers 2017).

4. Needs and requirements[2]

The development of a Land Administration framework is challenging because it has to support a wide variety of regulatory and policy environments. Interoperability between underlying technologies and systems is key in providing the necessary flexibility. There is an impetus to guide developing nations in a programmatic way to establish cost-effective, interoperable land-administration, to upgrade current manual processes (see Stubkjaer, et al., 2007) and to field automated solutions that can be flexibly adapted to new data sources and new technologies. Key is the ability of proposed Land Administration frameworks to support the regulatory and policy environments that are often unique to individual jurisdictions and nations.

This section provides an overview of needs and requirements discussed by an inventory by an international group of experts during the LADM Workshop in Delft in March 2017. Some of these needs recommend an extensions of LADM – without making it complex whereas some of them can be operationalised.

4.1 General

Cooperation. It is very possible to re-use and develop implementation standards in OGC together with the development of LADM Edition II in parallel to implementation of LADM. Commitment of professionals representing professional organisations is important here of course. As Christine Lacroix from ISO says: “When expertise from the whole world comes together to solve important problems, great things can happen[3] ”. Global organisations as UN and Worldbank are of crucial importance in setting needs and requirements. And as motivator.

[2]Some of the contents of this section are derived from abstracts prepared for the 8th LADM Workshop to be held in Zagreb April 2018 – Not yet included in the references

[3] https://www.linkedin.com/pulse/great-things-happen-when-world-agrees-christine-lacroix

Communication. The functionality and options for use of LADM should be better known and communicated. LADM is a flexible standards that can meet local requirements. It is not a prescriptive standard – it is a land administration expert language. It describes the common denominator in land administration worldwide. The rich functionality of LADM should be better and further promoted. UML instance level diagrams are very useful in communicating this functionality.

Common vision on use and applications of standards in land administration. Different disciplines working in land administration have their own view and interpretation to its importance, use and application. We talk about anthropologists, social scientists, lawyers, registrars, conveyors, notaries, geodesists, surveyors, remote sensing experts, valuers, brokers, spatial planners, land tax officers, cartographers, GIS, SDI and database experts, information managers – from academia, public and private environment. A common vision and agreement on the information, the structure of the information and the meaning and use of information is important. Of course OGC and ISO are involved here.

Compatibility. The first edition of LADM should be upwards compatible with future editions.

4.2 Extended scope of conceptual model

Valuation. The LADM is a conceptual data model which provides a standardized global vocabulary for Land Administration. A proposal to extend the scope of LADM with a fiscal perspective is available (Çağdaş et al., 2016, Çağdaş et al., 2017).This proposal provides a data model that could be used to construct information systems for immovable property valuation and taxation, and offer a data exchange option. The proposal (for inclusion in the second edition of LADM) provides a common basis for governments to direct the development of local and national databases, and for the private sector to develop information technology products. Another option could be to include this as an informative annex (similar to LPIS or INSPIRE CP annexes). Currently it is mentioned in the informative annex K (External classes: ExtValuation and ExtTaxation) of ISO 19152, Edition I (ISO, 2012).

The valuation discipline needs to be involved here. OGC needs to be closely involved in order to bring experience, good practise and workable solutions for mass appraisal.

Indicators. The GLII, see UN Habitat/GLTN, 2017 and also UN ECOSOC and African Union, 2016, seeks to derive a list of globally comparable harmonized land indicators, using existing monitoring mechanisms and data collection methods as a foundation. Internationally agreed standards will be key alongside agreed global concepts and evidence-based approaches.

Land Administration Performance Index Although, there has been significant progress in developing performance evaluation frameworks and benchmarks for individual LAS aspects, ontological and epistemological differences inherent in each LAS, however, have stymied attempts to cross-compare performance of Land Administration Systems in their entirety. There is need for a foundation of a Land Administration Performance Index – which is possible linked to existing global frameworks or initiatives.

Linking physical objects. Legal space and legal objects have its own geometry which is in many cases not (or not completely) equal to physical space and physical objects. Legal space should be linked to physical objects – by ids or re-use of descriptions of space. GML and CityGML offer options in this respect.

Indoor models. The users of the indoor spaces create a relationship with the space depending on the type of the building and the function of the spaces. Applying LADM allows assigning rights, restrictions, and responsibilities to indoor spaces, which indicates the accessible spaces for each type of user. A IndoorGML-LADM model is one example of linking physical and legal objects.

Marine Cadastre. The LADM standard is as published applicable to Marine Cadastres. Also there needs to have special attention for the transition zone from land – sea and Marine Spatial Planning (MSP). A normative reference to IHO S121 (Marine Limits and Boundaries) based on the LADM principles needs to be included in ISO 19152.

Spatial planning/zoning with legal implications. In principle this is a matter of coding zones in code tables (based on the local situations). It further implies integration of spatial planning and land administration environment. Re-use of zones from spatial planning into restrictions to land rights should be possible.

Other legal spaces: mining, archaeology, utilities. This may need specialisations in the data model.

4.3 Improvement of current conceptual model

Formal semantics/ontology for LADM Code Lists. For the domain of land administration, the localization issue extends from language names to the various organisations and institutions dealing with interests in land. Paasch et al. (2013), propose code lists as a mean of internationalization by which the classes of the LADM may be related to the jurisdiction concerned. The issue of code lists has been addressed by the OGC as well, namely in terms of the document 17-050r1 Code List Manifesto.

Meta data and tenure atlases are relevant in this context. Tenure atlases provide overview on tenure systems and the level of recognition. This may include areas without land markets and nature preservation etc.

More explicit 3D+time profiles. There is a model for representation of legal space with a datatype allowing the representation of volumes that are not completely closed. More functionality is required for a complete partition of space.

Extended survey model and legal model. This implies adjustments from field observations to the spatial database and the generation of quality labels.

Encodings/technical models. This concerns the further integration of LADM with existing standards: BIM/IFC, GML, CityGML, LandXML, LandInfra, IndoorGML, RDF/linked data, GeoJSON. Discussions are needed on getting INTERLIS available as implementation standard. BIM is very important in order to establish a link between BIM and land administration in relation to spatial planning and lifecycles of buildings.

Open data. This is about Coding of Rights, Right holders, Spatial Unit Types, etc. See Informative Annex J of (ISO 19152, 2012) – W3C.

4.4 Process models

Survey procedures and map updating. Cadastral map updating includes adjustments and transformations of field observations (collected ar different moments in time and with different survey instruments or use of imagery from different sources) to the spatial database. Management of areas is needed – there may be more then one area to be maintained for the same spatial unit – the legal area and the accurate area as calculated in the cadastral GIS. Implementation of tolerances to manage the differences should be flexible and purpose rekated. Results of subdivisions of spatial units may need to be shared with others systems. This includes results of readjustments and land consolidation.

Generic processes. Processes such as initial data acquisition concerns many millions of spatial units (amongst them parcels) where people-to-land relationships have to be determined, documented and reviewed.

In implementing countries specific strategies and more generic approaches are expected to applicable – whereas many of those processes can be operationalised. For example: participatory surveying where people themselves hold the GPS antenna or blockchain technology with less interference of professionals in transaction processes could be very well applicable for transactions in land administration.

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

A new class representing processes may be defined: a specialisation of the class representing sources – thereby creating a connection between the classes of workflow management module and LADM classes.

Processes can be organized on the basis of use of electronic signatures in case of applications and information requests with public and private keys and encryption/decryption.
Provision of information to data collectors for initial data collection or maintenance is a specific but very important process (task management, logistics). This provision of data can be paper based imagery or digital, paper based acquisition allows leaving the collected field boundary evidence to the local people. These include participatory approaches, roles, and on-line/off-line publication. Includes data on people ids, photos, signatures, fingerprints, video, voice recording, etc. And right types and restrictions, including disputes.

VGI and crowdsourcing for Land Administration. The approaches as highlighted include Volunteered Land Administration and Crowdsourcing. It is possible that rightsholders and communities collect and maintain their own data with a certain level of professional support for quality insurance etc. Participatory surveying is possible with GPS. Conversion from social tenure to legal tenure may require professional support – but it is easy to make this process complex and complex to make it easy. The Publication of parties, related rights and spatial units also via global services (as may be Google, Virtual Earth and Open Street Map and many others). Note: this type of publication may be in conflict with legislation – in some countries the land administration must be established within the country.

Integration. To ensure securing land and property rights for all, there needs to be concerted efforts to improve the production of data and the generation of information needed to record all forms of people-to-land relationships that will provide effective and efficient Land Administration Systems. There will

be a need for considerably more integration across the various national data and information systems and platforms in order to leverage the most effective data and analysis for evidence-based policy formulation and decision making.

Internationally agreed and open standards will be key to unlock the value of data and the wealth of information needed to recognise all forms of people-to-land relationships, which is vital for the well-being of all humanity and sustainable development.

5. Proposed actions

This section proposes a first overview of actions to be taken in cooperation with standardisation organisations. Note: countries without membership of OGC and ISO may be represented by global organisations and NGOs.

5.1 OGC

The OGC Land Administration Domain Working Group will focus on (see charter):
1. the examination of existing systems of land administration;
2. preparation of best practices that enable nations to address their needs in less time, cost, and effort through standards-based implementations[4]; and:
3. dialog on the integration of emerging information resources and/or technologies to assist nations in leapfrogging capability.

Additionally, the DWG will identify proposals for industry interoperability assessments, interoperability testbeds, pilots and experiments designed to bring together users and technology providers to test, demonstrate and validate best practices for use to guide the acquisition and implementation of sustainable, scalable and interoperable systems. The LandAdmin DWG cannot work in isolation. The LandAdmin DWG will work closely with the LandInfra DWG and SWG to identify existing standardization efforts underway in the OGC that reference Land Administration concepts to to work toward interoperability with LandInfra standards. In addition to engaging OGC membership, the DWG will leverage OGC's formal alliance partnerships and liaisons with other associations and standards development organizations (e.g. ISO/TC 211, Royal Institute of Chartered Surveyors (RICS), World Wide Web Consortium (W3C), OASIS, International Federation of Surveyors (FIG), and The Global Land Tool Network (GLTN)) to address interoperability issues that span the land administration community of practice, geospatial systems, and the broader IT environment. Examples include linkages with ISO TC 211 regarding the LADM (Land Administration Domain Model, ISO 19152:2012) standard as well as those Standards Development Organizations (SDOs) responsible for IT standards related to topics such as security, web and mobile services. Further, this DWG will be open for participation by any interested organizations and individuals.

In this context, there should be a focus on the nexus of BIM and 3D Cadastres to examine the challenges of integrating them. The challenges include leadership, advocacy, collaboration inter-domain and intera-domain, best practices, funding models for BIM and 3D Cadastre integration, BIM and city models data value/IP, standards and scales, bringing BIM to 3D Cadastre workflow, data models based on concepts and ontologies, cross-domain curriculum development and BIM/3D

[4] See http://www.opengeospatial.org/docs/is

Cadastre issues in the context of current social constructs such as public and private sectors. There is also a recognition of cross-domain collaboration in this space such as those between OGC, buildingSmart International and ISO. The need for academic community input more into BIM and 3D Cadastre standards is also required (Kalantari, 2017).

5.2 FIG

FIG will submit a New Working Item Proposal to ISO on the development of LADM Edition II. The proposal includes the following main scheduled LADM extensions:

1. Extended scope of conceptual model. This includes valuation, SDG LA indicators, Performance Index, linking physical objects, indoor models, marine, spatial planning/zoning with legal implications, other legal spaces: mining, archaeology, utilities;

2. Improvement of current conceptual model. This includes formal semantics/ontology for LADM Code Lists; more explicit 3D+time profiles; an extended survey model and legal model;

3. Encodings/technical models. This includes further integration with BIM/IFC, GML, CityGML, LandXML, LandInfra, IndoorGML, RDF/linked data, GeoJSON, and:

4. Process models for: survey procedures, map updating, transactions – including blockchain.

FIG will propose that OGC and ISO look for options to cooperate here in order to align and accelerate developments where possible. FIG may involve the Joint board of Geospatial Information Societies professional disciplines have to cooperate and join forces to achieve and maintain tenure security for all.

5.3 ISO – in close cooperation with OGC

If the New Working Item Proposal is accepted the ISO TC 211 will develop the next LADM Edition in co-operation with its members and following the ISO procedures. On the valuation extension cooperation is needed: International Valuation Standards Council, Standards on Mass Appraisal of Real Property and International Property Measurement Standards
There will be an extension of the scope of LADM with valuation.

Co-operation with ISO TC 307 on blockchain.

ISO and OGC could cooperate here in order to accelerate developments. Apart from the development of the next edition there will be attention to the management of code lists in order to include formal ontology and semantics.

5.4 UN GGIM Expert Group on Land Administration and Management

This Expert Group includes standards and Fit-For-Purpose approaches in Land Administration into the Framework for Sustainable Land Administration – as part of the overall Integrated Geospatial Information Management Framework. Promotion of the importance of flexible and implementable. The Framework for Sustainable Land Administration is a reference for developing and strengthening Land Administration Systems and a reference for Member States when developing, strengthening or

modernizing their national (or sub-national) land administration system The Framework shall describe key principles for a sustainable and interoperable land administration and management system that can efficiently and effectively document, record and recognise people-to-land relationship in all its forms …

5.5 LADM Users[5]

Develop the scientific foundation for LADM. Develop and communicate LADM implementations and applications – LADM could be better promoted:
standards like the LADM are crucial to jump-start new initiatives and are connecting top-down and bottom-up projects. It is very important that there is awareness of this at policy level. Policies should support the implementation of standards particularly when such standards are globally agreed.

6. Concluding remarks

There is a clear challenge for the global land community and for the global geospatial community: *secure land rights for all people, in all places, at all times*. The biggest challenge is to keep the information on land rights up to date and accessible at appropriate level of accuracy.

The geographic data/software industry provides tools, products and services to support a number of processes required in Land Administration. Image-based acquisition of cadastral boundaries needs access to huge image libraries – including historical imagery – to support large-scale implementations. Detection and selection of cloud-free imagery is needed to create cloud free compositions, possibly from different sensors. By using orthophotos to produce spatial frameworks, the imagery is typically linked to the national geodetic reference frame through GNSS. Furthermore, automated feature extraction and feature classification appear to be very promising developments for the generation of coordinates of visual objects from imagery, as well as Lidar and radar technologies can also be used for this purpose. 'Pre-defined' boundaries resulting from feature extraction may be plotted on paper or visualised in interfaces, and can then be declared identical to cadastral boundaries in the field.

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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. From 1985 until 1995 he worked at the TNO-FEL laboratory in The Hague. From 1995 until 2000 he was senior information manager at the Dutch Cadastre, where he was involved in the renewal of the Cadastral (Geographic) database. Since 2000, 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'. He is co-editor of the International Standard for the Land Administration Domain, ISO 19152.

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