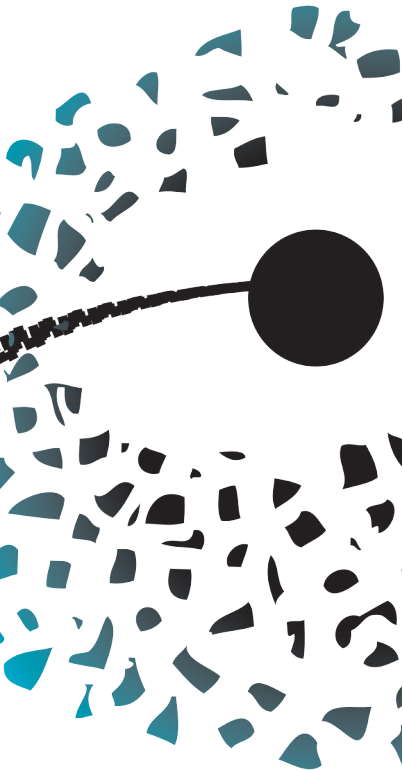
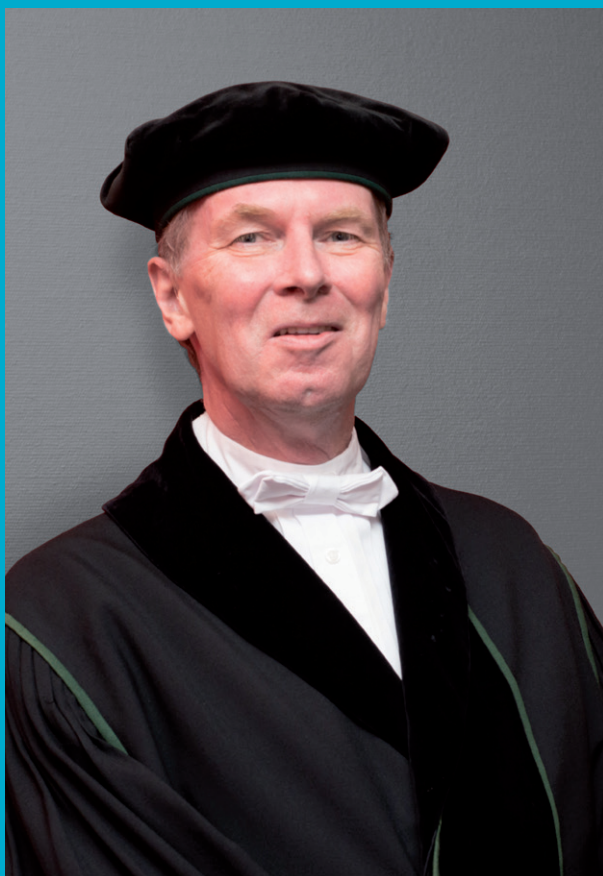

LAND INFORMATION MODELING

PROF. DR. CHRISTIAAN LEMMEN



UNIVERSITY OF TWENTE.



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LAND INFORMATION MODELING

INAUGURAL ADDRESS TO MARK THE OCCASION OF THE APPOINTMENT OF
PROF. DR. CHRISTIAAN LEMMEN AS PROFESSOR OF LAND INFORMATION
MODELING AT THE FACULTY OF GEO-INFORMATION SCIENCE AND EARTH
OBSERVATION, ITC, AT THE UNIVERSITY OF TWENTE ON THURSDAY 25
OCTOBER 2018.

CHRISTIAAN LEMMEN

COLOFON

Prof. dr. Christiaan Lemmen

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October 2018

*Dear Rector of the University of Twente, Dean of ITC, PGM Department, Kadaster International, ITC, Kadaster and other colleagues, students, family and friends, ladies and gentlemen,
It took me many footsteps on this planet before arriving here at this place. It is great honour to be here in front of you and to talk about land information modeling. To talk about what has been achieved in this respect and about the scientific challenges related to what must be done.*

SECURE LAND RIGHTS – A MISSION

People cannot live in trees. Or in the clouds or in the sea. Although, some people live in the clouds metaphorically speaking... Availability of land is essential to people. Right to adequate shelter is a human right.

The reality is that many people do not enjoy the pleasant feeling of having tenure security at their place. Less than 30% of the land rights is documented worldwide. 70% of the people worldwide are aware that land rights related to their piece of land are not documented. This has impact on the development and use of their land. And on human behaviour and social life. Talking about documented land rights means talking about land administration. Land rights for all means a well-functioning and accessible land administration available for all. Nobody leaves behind.

My chair in land information modeling will contribute to achieving secure land rights for the world. My involvement in projects all over the world and my participation in global discussions on this issue underpin this statement. I see this as a challenging, noble and feasible ambition and mission. My chair will focus on land information provision. On the modeling of ways to collect the required data, on data storage and on data dissemination and data use. Land rights are relationships between people and land. These relationships can be different from place to place, from region to region and from country to country. Different because of culture, religion, history and level of development. But the common denominator is linking people to a piece of earth. Linking people to polygons as surveyed on the earth's surface. This university and it's students have taught me that efficiency gains arise from designing and developing generic conceptual-level standards. Making systems founded on such standards is far easier then starting from scratch.

Standards development involves both scientific research as well as international processes of standardisation within the settings of the

International Organisation for Standardisation and the Open Geospatial Consortium. Land information modeling combines knowledge of information theory, geo-spatial technology, as well as elements of fields like anthropology, law and public administration. The generic conceptual models always needs to be tailored for use in national or local contexts. They need to be part of a broader land governance perspective in their implementation.

Linking people to polygons of land should happen in a fair way. Not only in the benefit of the rich and elite. Also in the benefit of the poor and vulnerable. Not only in the benefit of men. Also in the benefit of women. Not only in the benefit of older people. Also in the benefit of the younger people. In the benefit of all.

Land rights for all. This is the main driver for me personally and for the activities from my chair in land information modeling. I have to be realistic of course. Many land issues are with politicians and governments. My contribution is to provide models and approaches that may be implemented in support to the process of land rights for all. At ITC, here at the University of Twente we talk about responsible land administration that should be in place. From that perspective I will address some problems in today's land administration (Zevenbergen, et al., 2015).

This is about institutional setup, about bureaucracy and complex approaches. Good land governance requires good land administration. Good land administration requires good land information models. I will introduce to you a global standard for the land administration domain. Then I will talk about an approach for fit-for-purpose land administration and I will share my plans on research and further development on land information modeling. This is related to the development of a second edition of the standard for the land administration domain. And its operationalisation – technical and legal.

LAND ADMINISTRATION – FOR DEVELOPMENT

In about forty countries a land administration exists, in more than one hundred countries there is something available and under development and in about forty countries there is nothing. Large portions of land remain untitled in many countries.

A land administration documents and can inform about who owns what, where and how much. And in which way. This is not only about the establishment of formal rights. It is also concerns customary and informal rights related to land.

Land administration is the process of determining, recording and disseminating information about ownership, value and use of land when implementing land management policies (UNECE, 1996).

Land management policies concern such things as the provision of security of tenure for all or a fair taxation based on valuation of land and real estate. It may be about social justice based on access to land for all and on accepted ways of resolution of land conflicts. Or about peace building and security. Another purpose of a land management policy may be the development of smart and resilient societies. Or the access to basic infrastructure as water and sanitation. And about economic development with efficient land markets; environmental protection with a good management of natural resources. It is about land governance for prosperity, where economy, environment and social life and livelihood are balanced and developing in a sustainable way.

Weak land governance may cause of economic stagnation, eco-system degradation, injustice, dispute and conflicts. Land governance is fundamental in achieving sustainable development and poverty reduction and is therefore a key component in supporting the global agenda.

LAND ADMINISTRATION – IS THERE A PROBLEM?

Several problems can be identified in land administration all over the world. We talk here about complex institutional and organisational settings. Not always transparent. Or about bureaucracy and paper based approaches that are difficult to change. This is not in the benefit of citizens and society. But there are also reasons to be optimistic. Lets introduce some major problems first. It is important to identify those problems – good land information models may contribute to improvements.

First of all I must admit that in many countries, and not only less developed countries, I observe complex organisational and institutional settings underpinning the land administration. This is for example about fragmented responsibilities and tasks in land administration which are strictly allocated to the professions involved. This is due to different legislations. Those laws are often implemented with uncoordinated mandates. I can say that these organisations mostly do not have a tradition of cooperation in service provision. To register a piece of land or to perform a transaction on the land rights the citizen has to knock on many doors. Fragmented institutions imply distributed and often uncoordinated information management.

The coverage of land administration records is far from complete in most countries of the world. This means that cadastral coverage conforming to the situation on the ground is missing in most cases. Informal areas – as the word “informal” says – are visible in reality but simply do not exist with a representation in a formal land administration system. The same is true for most lands where customary traditions apply.

In order to make land administration effective the data need to be available. This means that land information management and modeling have to focus on data acquisition. Knowledge on aerial and land surveying has to be combined with knowledge on voluntary and participatory gathered information.

It is the ambition of the world¹ to provide women, men, indigenous people and local communities with secure rights to land, property and natural resources. This may be with documented or recognised evidence of tenure. Those who perceive their rights are recognised and protected². The 70% undocumented land rights concern billions of people to land relationships. Given the amount of data to be collected crowdsourcing seems to be an attractive approach.

As I explained – land administration in many countries functions under institutional fragmentation. In more countries than you might expect I see that land administration is paper based. Only paper based data have legal meaning in those countries. Paper based systems have a paper based transaction system. This transaction system and related workflow processes applications as provided by the citizens asking for service. Those transaction systems are often causing backlogs. Backlogs are more easy to manage in well-designed digital workflows. Backlogs in paper based systems create an environment where employees may be more sensitive for some extra motivation fees available to the applications. This may complicate replacement of paper based approaches by digital approaches.

Sometimes digital systems do exist and run in parallel workflows. Sometimes countries even have more than one computerised system for land administration. This is often the consequence of uncoordinated donor support. From data management perspective it is about unbelievable amounts of attributes that have to be collected and maintained for each parcel or person. It is about really complicated transaction processes

¹ <https://www.un.org/sustainabledevelopment/>

² <http://indicators.report/targets/1-4/>

and workflows. The same piece of land may be documented in different places and with different IDs. There are duplications in attributes.

Sometimes these organisations deal with different administrative territories, all of which may have subdivisions again: central, regional and local responsibilities. And many systems are related to administration of specific tenure types based on specific legislation and regulations. Many tenure types means many systems, many offices, many regulations, many archives, many roles. Replacing existing paper based workflows, land books, maps and archives by similar functioning digital environments may bring some efficiency benefits but is not the real solution. A comprehensive business process redesign with involvement of all institutions with responsibilities in land administration is a solution. This includes proper land information models. Proper models may not require institutional reform in all cases – such reform is very complex. But it requires cooperation and inter-organisational workflows. This one is not so easy to implement because a tradition in computerised approaches is only in its initial level in many countries.

LAND INFORMATION MODELS

I have to admit that at very few times I get the feeling that the existing systems are designed not to work. And also that innovations bringing change are very difficult to organise. Good land information models are the foundation of solutions in many problems. Right then I “feel” my mission: designing adequate knowledge models for development of land administration; capacity building and trying to bring, test and simplify approaches. All this in order to achieve tenure security for all within a reasonable timeframe. Yes. There is more than one problem in land administration. At the same time there are good reasons to feel and to be optimistic.



Figure 1
The UN Sustainable Development Goals

One reason to be optimistic is that land tenure is at the global agenda. You can find this in the Sustainable Development Goals, the New Urban Agenda³ from UN-Habitat and in the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests⁴ prepared by the Committee on World Food Security and UN FAO. This global attention brings positive feelings – there is an ambition to solve the land rights issue globally.

It is clear that conventional land information systems cannot adequately serve citizens. More flexible systems are needed for identifying the various kinds of land tenure in informal settlements. In my view data have to be manageable by the local communities themselves – until the data

are accepted for review and converted to the national system. A land information model includes information about the relations between people and land. A diversity of tenures should be recognised – as in the continuum of land rights approach (UN-Habitat, 2008).

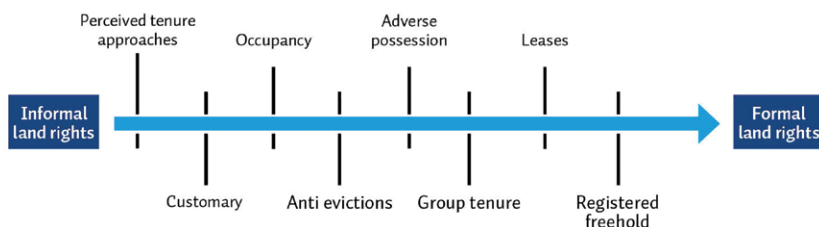


Figure 2
The Continuum of Land Rights (UN-Habitat, 2008)

Such model deals with real rights and personal rights. Real rights are rights over or in respect of spatial units, for example ownership, or long lease or usufruct. Personal rights are rights that parties have – for example fishing rights, grazing rights, or use rights. This means that informal and customary land rights are included in land information models. As well as information about persons, or parties: holders of rights. And information about administrative units, spatial units and buildings where the rights apply to. A land information model may further include restrictions to land rights and responsibilities in relation to land rights. And valuation may be included.

It must be possible to implement the land information model in a distributed environment. New roles of professionals and grassroots surveyors have impact on land information models. If the citizens point the boundaries of spatial units themselves and the data are collected by grassroots surveyors and then accepted by professionals this has to be labelled in the model.

Today products and services can be offered to users in society from complete digital land administration. In the Netherlands the land administration is harmonised in a nationwide system of authentic registers where data on citizens, companies, address, parcels, buildings,

³ <http://habitat3.org/the-new-urban-agenda/>

⁴ <http://www.fao.org/cfs/home/activities/vggt/en/>

topography are fully integrated. And even further integrated with other authentic registers such as income and tax. Further harmonisation of spatial data is a policy in the European Union in support of the implementation of environmental policies. The cadastral parcel is a core element here. Many universities and research centres are involved and cooperate with data providers.

Many developing countries want to develop in a similar direction. This was one of the main reasons behind standardisation efforts. The 'Land Administration Domain Model' was approved as an official International ISO Standard in 2012 (ISO, 2012). Shortly after its publication of this key achievement in land information modeling, the standard was implemented and used in several countries already. Societies benefit from knowledge management in this way. The social tenure domain model is another achievement. This specialisation of the land administration domain model has a focus on the land use rights of the poor and vulnerable.

All this means that much has been done already. Knowledge has been generated and exchanged. Standards, methods, guidelines and tools have been developed, keeping track with the fast developing technology for data collection, management and exchange. Infrastructures and information services are being built. We will express the main achievements in some more detail now.

THE LAND ADMINISTRATION DOMAIN MODEL – LADM

Land Information Models are the core, the essence of a land administration system. What to include and how to structure a model? Experience teaches that it is far more difficult to start from scratch than starting with a model that can be adapted to the local situation. The people designing it are the brains of the organisations where the land administration is kept. Land Information Models need continuous attention by high level experts.

A group of about 60 land administration scientists and experts from the profession initiated the development of the land administration domain model about ten years ago. Preparations, together with Prof. Peter van Oosterom started even five years before in 2002. This illustrates how complex it is to find the common denominator in land administration and also how complex it is to start from scratch.

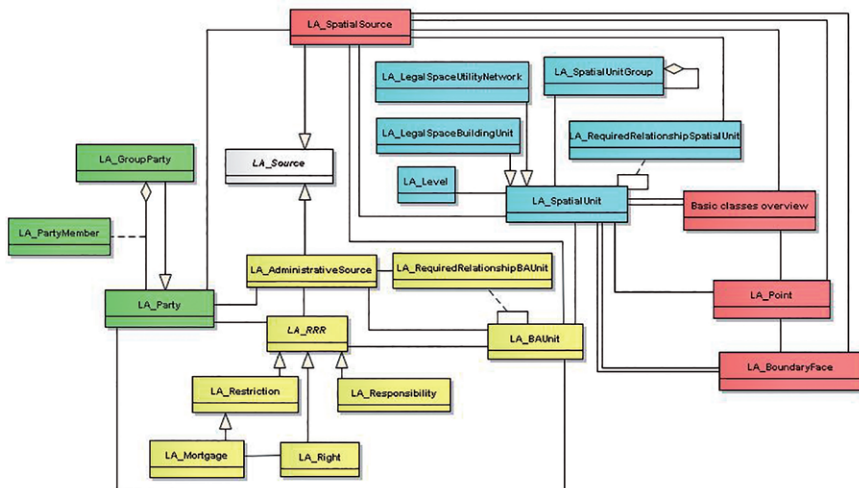


Figure 3
The Land Administration Domain Model (ISO, 2012)

Geodesists, lawyers, economists and anthropologists were involved. This effort was supported by UN-Habitat, the Food and Agricultural Organisation of the UN and the International Federation of Surveyors. A requirement in design was that this conceptual model should be able to function as the core of any land administration system. And the standard should be flexible. It should be widely applicable and function as a gathering point of a state-of-the-art international knowledge base on this theme. In essence, a standard is an agreed way of doing something. Standards are the distilled wisdom of experts in their subject matter. Standards are knowledge that help drive innovation. Standards can make organisations more successful and people's lives easier and safer. The land administration domain model is a knowledge model. It captures the semantics of the land administration domain. It builds on top of the agreed foundation of basic standards for geometry, temporal aspects, metadata, and also observations and measurements from the field.

All this is required for communication, for system design, system development and system implementation purposes. And for purposes of data exchange and data quality management. Use of standards contributes to the avoidance of inconsistencies between data maintained in different organisations, because data duplication can be avoided as much as possible. Such a standard will enable GIS and database providers and/or open source communities to develop products and applications. This is initiated now in the Open Geospatial Consortium. The land administration domain model provides a shared ontology, defining a terminology for land administration. The model is a flexible conceptual schema. It has three basic packages: parties, rights/restrictions/responsibilities and spatial units. The model facilitates data services and data exchange with and from distributed land administration systems.

The land administration domain model allows for a flexible, step by step approach in the development of a land administration based on the needs, priorities and requirements of users and society. This can be combined in a natural way with organisational development. This makes the concept of the model a basis for strategic development in land administration. It is a conceptual model. The purpose of the model is not to replace existing systems. That would be impossible and is not acceptable. Its purpose is to provide a formal language for describing existing systems, so that their similarities and differences can be better understood.

The land administration domain model and also the social tenure domain model are descriptive and not prescriptive.

Land administration is a large field; the focus of this International Standard is on that part of land administration that is interested in rights, responsibilities and restrictions affecting land, or water, and the geospatial components thereof. The land administration domain model provides a reference model which will serve two goals. The first one is to provide an extensible basis for the development and refinement of efficient and effective land administration systems, based on a model driven architecture. This development can be done by commercial providers of geographic information systems, by suppliers of devices for collection of data, by open software communities or by software builders or by national governments. The second goal of the domain model is to enable involved parties, both within one country and between different countries, to communicate. This communication is based on the shared vocabulary, implied by the model.

THE SOCIAL TENURE DOMAIN MODEL – STDM

The common pattern for land administration consists of objects, those are spatial units; rights, those are real rights and/or personal rights, and subjects those are the holders of the right related to the object. This is the basic structure for all well-functioning systems and is quite easy to understand. It is implemented in the social tenure domain model. It is relatively easy to digitise a paper based system and create a computerised system.

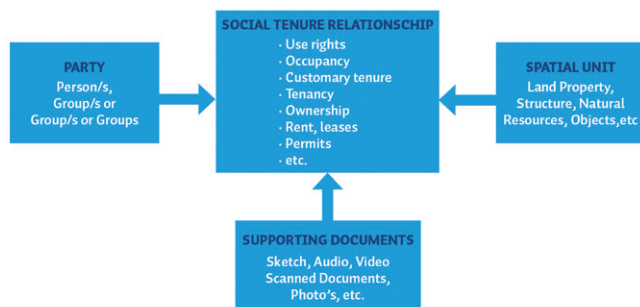


Figure 4

The Social Tenure Domain Model developed by the Global Land Tool Network

The triplet can be used in modeling the interface between government and citizens in a very generic way: think about building and other permits, licences, complaints and notifications.

The social tenure domain model⁵ (FIG, 2012) has been an initiative together with Prof. Jaap Zevenbergen here at ITC here at the University of Twente and Dr. Clarissa Augustinus from UN-Habitat to support pro-poor land administration. The social tenure domain model is meant specifically for developing countries, countries with very little cadastral coverage in urban or rural areas. It is also meant for post conflict and post disaster areas, for areas with large scale informal settlements, or for large scale customary areas.

The focus of the social tenure domain model is on the relationships between people and land, independently from the level of formalisation

⁵ <https://stdm.gln.net/>

or legality of those relationships. Overlapping claims to land may be included. Informal or customary tenure relations can be integrated in a land administration but most land administration systems are not designed for this. The reason is simple: social tenure relations have legitimacy but are not legally recognised and, for that reason, cannot be institutionalised. When it is about land rights there is no inclusiveness for all.

It should be emphasised that the formally documented land rights are often only available for the elite and not so much for the poor and vulnerable and many others. Women's access to land is mostly not documented. In case of divorce, or when the husband passes away, women may lose access and have to live on the street. The challenge for the global land community and for the global geospatial information communities is clear: bring secure land rights for all people, in all places, at all times. The social tenure domain model is also available as open source software and is widely used.

A social tenure domain model implementation is about recognition of all forms of tenure. The sustainable development goals of the United Nations talk about *"access to basic services, ownership, and control over land and other forms of property, inheritance, natural resources, appropriate new technology, and financial services including microfinance"*. UN FAO wants to improve governance of tenure of land, fisheries and forests with the overarching goal of achieving food security. Governance concerns all forms of tenure, including public, private, communal, collective, indigenous and customary.

Providing a generic data model for land administration based on common ground, widely accepted and useful for many people is worth every effort. To find that it is possible to use it in so-called informal and customary environments. To look for a basis to apply the model for supporting equal land rights for all. To prepare for possible land grabbing by mapping the existing situation fast and with unconventional approaches as point cadastres, satellite images, boundary drawing instead of measuring, with participatory approaches, accepting that improvements may be needed later.

FIT-FOR-PURPOSE LAND ADMINISTRATION

A fit-for-purpose set of guidelines and approach have been developed for land administration. Prof Stig Enemark from Denmark was the principle author. I was contributing author together with Robin McLaren from Scotland. The fit-for-purpose approach (UN Habitat/GLTN/Kadaster, 2016), (FIG/Worldbank, 2014) argues for cost-effective, time-efficient,

transparent, scalable and participatory land administration, including participatory surveying and crowdsourcing. Often it is sufficient to identify visual boundaries in the field using imagery. Land administration systems are as plain as possible at the start and can improve over time whenever necessary or relevant. It is a dynamic process: purposes evolve as e.g. the economy and technology develop over time, and so does the administration as well. Such an approach must be gender sensitive, transparent and highly participatory.

A fit-for-purpose approach in land administration is focusing firstly on the “what” in terms of the end outcome and then designing the “how” to be the most “fit” for achieving the purpose. Purposes of land administration can be single or plural. Examples are provision of secure tenure rights for all and access to land for all or provision of sustainable land use. Those can be purposes defined by communities or government or both and laid down in land management policies as said. Fit-for-purpose is about flexibility in terms of demands for accuracy. High geometric accuracy is not needed in support to many purposes. This is really an issue because high geometric accuracy standards may cause serious delays in data acquisition.

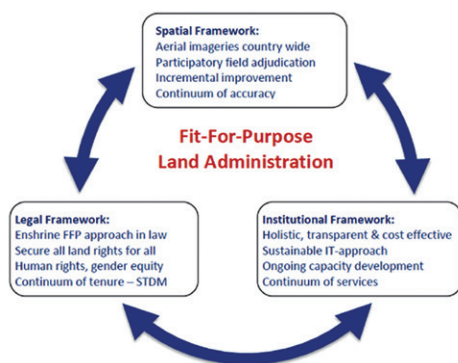


Figure 5

Fit-For-Purpose Land Administration (UN Habitat/GLTN/Kadaster, 2016)

The concept includes three core components. Those are the spatial, the legal, and the institutional frameworks. Each of these components includes the relevant flexibility to meet the actual needs of today and can be incrementally improved over time in response to societal needs and available financial resources.

High accuracy of a quality link between people and land is needed in many purposes – but often not available because of institutional fragmentation. Flexibility is further needed for recording of a range of different tenure types, and for shaping the legal and institutional framework to best accommodate societal needs. A fit-for-purpose approach will ensure that basic and appropriate land administration systems are built within a relatively short time frame and at affordable costs ... and the systems can then be incrementally improved over time.

WHAT HAS TO BE DONE

Quite a few things have to be done now in further knowledge development as to be captured in the land administration domain model⁶.

People to land and land to people

One key aspect is that we will focus on all elements as per the definition of land administration. So far research in land information modeling has focused on land rights. Not so much on the restrictions and responsibilities related to land rights and land. What I mean is that it is not only what the people can get from the land and what the land can give to the people. It is also about what the people can give to the land and what the land can get from the people. It is about people to land relations and also about land to people relations. This means inclusion of spatial planning/zoning with legal implications into the land administration domain model. 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 and utilities.

Valuation and taxation

More attention is needed for developing the valuation domain as a knowledge model in the land administration domain model. Not a popular subject may be. But a condition for being independent as a country. Institutions such as the World Bank support responsible taxation for a sustainable future. This requires broadening of the scope of the land

⁶ *Some parts of this section are based on Uitermark, Van Oosterom, Zevenbergen, Lemmen (2010): From LADM/STDm to a spatially enabled society: a vision for 2025, Annual Bank Conference On Land Policy and Administration, 26-27 April 2010, Washington, USA*

administration domain model with a valuation module. Scientific research is ongoing with Delft University of Technology with a focus on the design of a data model that could be used to construct information systems for immovable property valuation as basis for taxation. 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 – for example cadastre, land registry, building and dwelling registries.

Legal and physical objects

Legal space and legal objects have their own geometry, which is in many cases not, or not completely, aligned with physical space and physical objects. Legal space should be linked to physical objects – by IDs or re-use of descriptions of space. BIM/IFC 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 the land administration domain model allows assigning rights, restrictions, and responsibilities to indoor spaces, which indicates the accessible spaces for each type of user. An Indoor GML-LADM model is one example of linking physical and legal objects.

Marine environment

A normative reference to IHO S121, that is about Marine Limits and Boundaries based principles as from the land administration domain model, needs to be included.

Indicators

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 harmonised 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 – possibly linked to existing global frameworks or initiatives.

Processes

Blockchain technology in transaction processes could be very well applicable for transactions in land administration.

The 'pivot' between land administration domain model and the blockchain can be the source document. In the domain model this source

document is the document describing the change in data based on legal or administrative transactions. The blockchain can be applied in different ways to processes. Depending on the way the blockchain is used, it will deliver different levels of trust to the process. Options for further research have been proposed and will find attention in my chair – in close cooperation with experts from Kadaster. It is relevant to investigate if and how a blockchain based land administration can contribute to peace building – because reconstruction of ownership and land use rights may be possible. This is helpful in land redistribution processes.

Conversion of social tenure to legal tenure is a process that may require different layers with related attributes. The same is valid for handling conflicts, for processes and land readjustment and land consolidation and for geometric quality improvements.

Processes can be organised 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 and logistics.

Relevant are processes as the provision of cloudfree imagery for field data collection. And automated feature extraction – with a focus on visual boundaries between plots. Many of them can be cadastral boundaries. Research in this area by Dr. Divyani Kohli and Dr. Mila Koeva at ITC is very promising in support to cadastral data acquisition in specific areas.



Figure 6

Crowdsourcing in land administration. Citizens walk the perimeter of their land with a GPS antenna and point the boundary points. The coordinates and other information (ID, photos of the rightholders, photos of documents bringing evidence) is collected with mobile devices. Photo by Liliana Merizalde

Crowdsourcing

Emerging approaches in land administration should include crowdsourcing in my opinion. This approach proved to work at scale in topographic mapping. A large scale implementation in land administration would be a revolution. The professions have to be involved – but probably in different roles. Not so much as data collectors but may be more as organisers and managers. It is possible that right holders and communities collect and maintain their own data. Data collection may very well be done by grassroots surveyors – with professional support on quality insurance and data acceptance. Participatory surveying is very well possible with imagery and global navigation satellite systems.



Figure 7

Automated feature extraction of visual boundaries can be very supportive to cadastral boundary acquisition

This volunteered information gathering has many dimension that require further research. This is related to quality and liability issues. There is a huge difference if the surveyors point and measure the boundary or the people do it themselves.

Good information models can support acquisition approaches where overlapping claims to collected data can be brought via web services

for a certain period of time. Prescription mechanisms may be used. If all data are available illegal occupation may be automatically identified from imagery.

Good information models applied in computerised environment may further be used to manage and avoid backlogs and to offer transparency in processing applications: all applications can be processed at the day of arrival or within a few days from that. In an interorganisational workflow this is not based on tradition and research is required in support to a good design of such processes.

Updating

The currently established updating procedures are expected to be simplified in the future. For example, to split and sell a part of a parcel requires professionals, such as notaries, surveyors and registrars, each performing certain sub-tasks. Based on authenticated identification of persons and trusted reference material seller and buyer collect the coordinates of new boundaries of the split part of the parcel themselves and complete the transaction. In this context, high-resolution and up-to-date georeferenced imagery can be used, via web services. Dual frequency antennas for GPS observations of the boundaries are already available for mobile phones. And Skype-like communication is possible with the land administration authorities.

Cadastral map updating includes adjustments and transformations of field observations. Those field observations are collected at different moments in time and with different survey instruments or using imagery from different sources to the spatial database. Management of areas is needed – there may be more than one area to be maintained for the same spatial unit – the legal area and the accurate area as calculated in the cadastral GIS. The calculation of areas is of a sensitive nature. It is the outcome of the process of surveying and mapping. Surveyors understand that this outcome is related to standard deviations – but they do not really communicate this.

Spatial Data Infrastructures

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.

Domains will have links with other domains. For land administration systems, as the cornerstone of the information infrastructure, these links with other registrations are numerous and include persons, buildings, rights or topography, for example. Satellites can monitor changes, providing information for linking to rights, restrictions and responsibilities to spatial units and other data layers. Inclusion of land administration in global spatial data infrastructures is under development – amongst others within Expert Group on Land Administration and Land Management, chaired by Kees de Zeeuw, director of Kadaster International. This group functions under the umbrella of the United Nations Committee of Experts on Global Geospatial Information Management. A characteristic of all these registration issues is that people, spatial objects or spatial phenomena are important, and so to the relationships between them.

Land rights in 3D

A conventional cadastral map or cadastral spatial database represents cadastral parcels or spatial units with social tenure in two dimensions. Modern land use requires that land administration systems will need capacity to manage spatial units with related to land rights in three dimensions. This may be linked to physical spaces.

Life Cycle

A building has a life cycle. This starts with design followed by construction and use and the demolishment. At Delft University a very interesting research is ongoing now in re-using the building materials after demolishment of a building. This requires descriptions of those materials in a land administration. This has impact on the information model.

AMBITION

I wrote in my PhD thesis that for some people land information modeling can be a lifetime job. I am amongst them – as you may have observed. I'm happy to know quite a few of them as colleagues from Kadaster and from other countries. My generation of land administration modellers has been heavily involved in bringing the cadastral maps and registers from analogue to computerised environments. A unique event with unique and specific knowledge built up for that purpose. This conversion could only be performed because we had data models where the analogue data, including spatial data, could be digitally captured, represented and retrieved.

Today those models serve many purposes as I explained and now can be seen that there is global attention to land administration domain models.

This includes the UN Food and Agricultural Organisation, UN-Habitat, the UN – Division for Ocean Affairs and the Law of the Sea, the United Nations Initiative on Global Geospatial Information Management, the International Federation of Surveyors, the International Hydrographic organisation, the World Bank, the International Valuation Community, the Registrars Community, the Royal Institution of Chartered Surveyors and ISO/TC 211 members. This motivates me in achieving a second edition of the land administration domain model and its operationalisation. My further ambitions are with the school for land administration studies.

Land Administration Domain Model – Edition II

A New Working Item Proposal has been prepared on the development of a second edition of the land administration domain model. I was happy to submit this proposal to the Technical Committee 211 of the International Standardisation Organisation recently.

This proposal includes an extended scope of the land administration domain model with a valuation and land use planning perspective. 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. Further proposals concern the inclusion of land management processes – such as the conversion of social tenure to legal tenure; blockchain based transaction mechanisms; the integration with Building Information Modeling, marine limits and crowdsourcing. Requirements related to peace building and security, disaster management and smart and resilient societies need further attention and research. A PhD study at ITC, University of Twente, by Eva-Maria Unger builds the link between disaster management and land administration.

One year is scheduled to gather those requirements. My chair will be heavenly involved in this process of knowledge building – results can be expected after five years from now.

Open Geospatial Consortium

The members of the Open Geospatial Consortium drafted a charter⁷ for a land administration domain working group. This charter describes how to improve the effectiveness and efficiency of land administration systems by optimising the use of the standards from the Open Geospatial Consortium 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 the land administration domain model, 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 land administration domain working group of the Open Geospatial Consortium 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 model. There is a need for good practices, processes, implementation guides, expertise from past implementation.

I'm chairing this group together with Mohsen Kalantari from the University of Melbourne and Peter van Oosterom from Delft University of Technology. It is my ambition to achieve the goals of the land administration domain working group.

School for Land Administration Studies

Yes. There is insufficient capacity. Generations of professionals in many countries are educated in academic environments where the knowledge is brought up on the existing land administrations with all its customs and tradition. Managers, professionals and involved scientists may have the insight that things have to change – in a process from complexification to simplification. But where to start? It is very complex to simplify – where it can be seen from the existing situation that it is very simple to complexify. If you have the choice as a student interested in land administration and working there as a professional or scientist: to which academia to go? To a place with tradition and history where conventional approaches are being taught? Or to ITC where changes agents and all kind of unconventional approaches are in the spotlights every day? Going back home from Enschede with a MSc from ITC you have to bring the change in an environment where this may be not in everyone's interest. To me it is really an issue that deserves more attention. Change is needed. But how to organise this – including institutional change.

⁷ <http://www.opengeospatial.org/projects/groups/landadmin>

In any case it can be said that systems and land information models have to be ready and equipped for implementation of consequences of changes. It is not so nice to see that in so many less developed countries there are so few people who can design the required data models, develop the required applications and implement the required systems. Tools are urgently needed here allowing taking advantage from modern land administration systems in support to good governance. One of the most relevant tools is a software application built on top of a data model.

The School for Land Administration Studies is established in 2005 – as joint initiative of my employers the Faculty for Geo-Information Science and Earth Observation – ITC – here at the University of Twente and the Netherlands Cadastre, Land Registry and Mapping Agency – Kadaster. It is a recognised brand by land professionals globally. A combined academic and professional working surrounding, very integrated as in my case at ITC and Kadaster International is really very optimal in achieving this. The Academia brings scientific concepts, models and methodologies. The profession brings operations, management and governance. From the school for land administration studies we help countries in implementing fit-for-purpose land administration design and strategies, in developing country profiles for the land administration domain and in developing change agents and in evaluating land administration impact. In this context we set up research an education – this is my third ambition.

The ambitions related to the development of the second edition of the global standard for land administration, to the operationalisation of this standard and to the School for Land Administration Studies are realistic and achievable. I hope this will bring a small contribution to a better world.

WORDS OF THANKS

I would like to express thanks and gratitude to the Rector of the University of Twente, the Dean of ITC and the appointment advisory committee for their support to my appointment – in the chair “Land Information Modeling”. Thanks for your trust in my capabilities.

To my colleagues at ITC, especially the land administration group and the PGM Department I like to bring words of thanks for your always positive and very motivating cooperation. So nice to work with you and to be with you. Jaap, you made a serious effort to bring me here. It took some time – but here I am. I look forward to a very good cooperation in the years under arrival.

I also wish to thank the board of the Netherlands Cadastre, Land Registry and Mapping Agency for their support to my work. And my colleagues at Kadaster International. What a fantastic environment. What a privilege to work there and to be with you – thanks for your collegiality. It is intensive and with a lot of fun. Special words of thanks to Kees de Zeeuw my director in Kadaster International. Kees thanks for your support - we achieved a lot. And most special words of thanks to Pauline van Elsland for all your help and advice and for always being there. And to Paul van der Molen with whom I worked for many years in Kadaster and at ITC. Thanks Paul, I learned a lot.

The fact that I am standing here in front of you was made possible by many people. I cannot mention all of you. Thanks!
Thanks go to my mother, Kitty, my family and all my many friends.
My father, Gerrit, cannot join the celebrations, I’m sure he would have been happy.

Most important of all I would like to thank my beloved wife Adrie and Annika, Arjen, Wendy and our granddaughter Quinn. What a happiness. It is not always easy to live with such a person as me. Away from home half of the year and busy the other half. Thanks for your flexibility, your understanding, support and love.

Ik heb gezegd

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