

The Social Tenure Domain Model – Design of a First Draft Model

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Key words: Access to land; Informal Settlements; Land Management; Low Cost Technology; Security of tenure; Standards, Pro Poor Land Management, Social Land Tenure Domain

SUMMARY

During the 5th FIG Regional Conference in Accra, Ghana, 8-11 March 2006, a set of requirements for the development of a Social Tenure Domain Model was presented (Augustinus et al, 2006). Based on those requirements a draft version of this Social Tenure Domain Model has been developed, the results of this development are presented in this paper. This paper will analyse if the social land tenure system requirements are really covered, if implementation of pro-poor land management, as launched by UN HABITAT is really supported, and if management of geo-information from multiple sources (for maintenance of people - land relationships) is really supported. In short, it can be concluded that most of the requirements are indeed supported and that a few aspects require additional research. In addition, attention has been given to the integration of UN HABITAT's continuum of land rights, as well as the integration of a wide range of spatial units. The Social Tenure Domain Model is developed as a specialisation of the International Federation of Surveyors' (FIG) Core Cadastral Domain Model, specifically for developing countries, countries with very little cadastral coverage in urban and/or rural areas, for post conflict areas, countries with large scale informal settlement and/or large scale customary areas.

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1. INTRODUCTION

Modelling the relationships between people and land as a basis for land administration and/or land management is complex. The focus of this paper is on modelling the relations between people and land; independent from the level of formalisation and/or legality of those relationships. It is a search for a domain model that can be used as a basis for the development of a land administration system that can support all forms of land rights, social tenure relations and overlapping claims to land (e.g. in post conflict areas). In the development of the FIG Core Cadastral Domain Model (CCDM) efforts were made to include customary and informal tenures (van Oosterom et al, 2004). In (Augustinus et al, 2005) it was stated that not all the requirements could in fact be addressed by the CCDM and that additional domain requirements would still need to be included. These additional requirements are identified in the paper, and are now being addressed through the development of a Social Tenure Domain Model.

This paper outlines what would be needed to implement these requirements in terms of a flexible, standardised, Social Tenure Domain Model (STDM). It will analyse if the broader social land tenure system requirements can really be covered in the STDM, if implementation of pro-poor land management, as advocated by UN HABITAT, also through the Global Land Tool Network (GLTN), can really be supported by the STDM, and if management of geo-information from multiple sources can also be supported. Further attention will be given to assessing whether it is possible to integrate UN-HABITAT's approach of the continuum of land rights, as well as the integration of a wider range of spatial units which UN-HABITAT and its GLTN partners are currently using in informal settlements. The Social Tenure Domain Model is being developed as a specialisation of FIG's Core Cadastral Domain Model.

Section 2 presents the context of the STDM: the global challenges and the resulting need for pro poor land management. Section 3 also outlines the problem, in regard to why new land administration approaches are needed, using examples from several developing countries. The different types of spatial units, persons, and social tenure types which should be considered are described in Section 4. The resulting design of the STDM is given in the form of class diagrams in the Unified Modeling Language (UML) in Section 5. Next, in Section 6, the fulfilment of every requirement is checked against the possibilities offered by the STDM. Concluding remarks and future work is described in Section 7.

2. GLOBAL CHALLENGES

UN-HABITAT's global mandate covers all human settlements, and the organisation is known as the agency for cities and other human settlements (Augustinus, 2005). In the cities of the developing world, slum upgrading and prevention is one of UN-HABITAT's key tasks, where security of tenure and land management are of critical concern. Almost one-third of the world's population will live in slums by 2030.

There is growing concern about slums, as clearly stated in the year 2000 in the United Nations Millennium Declaration (Augustinus, 2005). In light of the increasing numbers of urban slum dwellers, governments have recently adopted a specific target on slums. It is contained in the Millennium Development Goal 7, Target 11, which aims to significantly improve the lives of at least 100 million slum dwellers by the year 2020. Because land is literally at the base of slum formation, addressing the slum challenge means taking the land issue seriously. Given that experience has shown that it takes 15-25 years to change a country's land administration system, we cannot afford to wait if we wish to improve the lives of slum dwellers now and to meet the Millennium Development Goals.

Land titling is important and necessary, but it is not enough on its own to deliver security of tenure to the majority of citizens in most developing countries. Customary tenure and informal settlement tenure has a very strong influence. Individual land titling often works against the needs and aspirations of ordinary people, also because of its cost. There is an urgent need to have a land information system that works very differently from the conventional land information system (Augustinus, 2005). Land tenure types which are not based on the cadastral parcel and are not registered require new forms of land administration systems, including land information management systems. This challenge was accepted by the former President of FIG, Professor H. Magel, at UN-HABITAT's 2006 World Urban Forum where he stated that, FIG would actively engage in the extension of the current conventional land administration systems in order to also address the needs of the poor. This paper is an attempt to work towards supplying a solution (Magel, 2006).

3. PROBLEM STATEMENT: WHY NEW LAND ADMINISTRATION APPROACHES ARE NEEDED

In addition to the global perspective outlined above, many countries and areas are introducing new approaches to tenure which are not based either on registered rights and/or the cadastral parcel. Below we outline some of the innovations which are taking place around the world which require new forms of domain models, after that we will show that these requirements can be addressed by the STDM.

Some countries develop land legislation, which endeavours to integrate customary tenure within the formal system. Bosworth (2002) reports on Uganda where the Land Act enacted in 1998 provides for methods to adjudicate customary rights, and the issue of certificates of customary ownership and occupation certificates for tenants on *mailo* land as well as the

establishment of a Land Fund to assist in the market-based transfer of rights between tenants and landowners. These certificates will be mortgageable. Also, the Act recognises group rights to land by means of the registration of communal land associations with elected management committees.

In Mozambique the new Land Act, 1997 recognises customary rights in the form of co-titling, as well as the need to consult with the local communities as part of the authorisation process for new investments (Quadros, 2002). In Namibia there is a new Land Law that will address the broad issues of communal land reform by means of the creation of regional land boards (Pohamba, 2002) for rural areas. A flexible land tenure system has been proposed by the Namibian government for the urban areas (Fauerholm Cristensen, 2004). A similar approach can be recognised in Tanzania (Kironde, 2005) where residential licenses in urban areas exist, which are intended to be converted to full title later. In Ethiopia a certification in two phases has been instituted, and over 5 million certificates have been delivered (Abebe-Haile, 2005, Holden, N.D.). In Uganda certificates of ownership and occupancy can be used in parallel (Oput, 2005), in Lesotho 3 forms of leases are under development: primary, demarcated and register able (Selebalo, 2005).

Van den Berg (2000) states that under a new Act in South Africa communal titles can be granted to Communal Property Associations. Common properties can further be: indigenous or co-operations (GTZ, 1998). In Bolivia the INRA Act (1996) (Ley Instituto Nacional Reforma Agraria) provides for the recognition of *Tierras Comunitarias de Origen* (TCOs), i.e. land belonging to indigenous groups (Zoomers, 2000).

Many different types of land use rights exist; e.g. usufruct, tenancy, lease, long lease, etc. etc. Land rights can be religious; e.g. the *waqf* in Islamic land rights, apart from the *milk* (private) and *miri* (government) rights.

Use of apartments can be formal or informal. It is even possible that apartments (the 'individual units' in an apartment block) have been formally privatized without related regulations for 'shared units' (threshold, stairs, roof, corridors, elevators, etc.). Also, state or public lands can be national, municipal, and can be allocated for a public purpose, e.g. road, school or hospital.

The recognition of customary rights also devotes attention to rights of sheep and cattle farmers. In many countries there are serious conflicts between traditional nomadic sheep or cattle farmers and arable farmers about grazing and farming lands (such as Kenya, Tanzania, Rwanda). Related to this is the right of access. Rights of access across land -most informal settlements do not have proper roads and access is across 'private property'. Access rights are formalized as servitudes in some systems. It can also concern access to water or agricultural or other lands.

Tanzania's new village Land Act provides for the sharing of pastoral and agricultural land by sheep and cattle farmers and arable farmers on the basis of adjudication and mutual

agreements (Mutakyamilwa, 2002). Even ‘illegal relationships’ between persons and land, e.g. in case of uncontrolled ‘privatisation’ (Trindade, 2003) exists (reflecting the reality of the real world in the system), as well as cases of ‘disagreement’, ‘occupation’ or ‘conflict’, resulting in overlapping claims to land. In this way a systematic recordal of conflicts on lands could support the realization of solutions.

As indicated there are therefore a wide range of rights being developed which cannot be easily recorded in the conventional land administration and land information management systems, in addition to the wide range of social land tenures such as informal settlements, customary tenure and post conflict tenures which need to be managed.

The conceptual framework for the different types of rights described above, as understood by the authors, is drawn from a definition para-phrased from an IRGLUS conference (1999): ‘A right is a claim recognised by a social system. Some rights are informal and only recognized by a local social system, such as an informal settlement and/or customary community. There should be a range of rights in a country, which are legally enforceable claims, and which can be asserted and defended in a forum such as a court. These rights should occupy a continuum from rights evidenced:

- Through law, such as anti-eviction laws;
- By contract, both written and/or oral;
- By local forms of recordal, such as community registers, local authority voter’s rolls, electricity bills;
- By information held on paper or digitally (GIS/LIS) maps, such as cadastral information, local authority information, village sketch maps;
- By deed or title registration, in terms of publicly registered title deeds or private conveyancing (freehold, some forms of leasehold)’.

A variety of tools that can be used within a range of technical, social and legal processes should be developed to enable people, especially the poor, to assert their land rights. The role of the state is to legitimate the processes through which these rights are asserted.

4. SPATIAL UNITS

The STDM makes it possible to put rights into a system which are not registered rights, nor registerable, and are claims, and/or need to be adjudicated both in terms of the ‘who’, the ‘where’ and the ‘what type’. The focus is on recorded rights (or social tenure relationships) and not on registered rights; this means on personal and not on real rights. We have to deal with the impreciseness and possible ambiguity of the description of the rights both in terms of ‘who’, ‘what’ and ‘where’, and also in terms of not necessary registered, and a range of rights in the continuum simultaneously.

The spatial unit forms the basis for recording the people – land relationship. Objects on which customary rights are exercised are not always accurately defined (Neate, 1999). Within this

context Österberg (2002) advocates a flexible and non-traditional approach to the spatial component. Land rights might pertain to a relationship with the land that is in accordance with the standards and values of the relevant community, although these rights will need to be defined to provide third parties with meaningful information. In these situations the parcel of land, i.e. the object on which the rights are exercised, might be defined in a manner other than accurate land surveys and geometrical measurements. Österberg (2002) shows pros and cons of the various perspectives. Fourie (2002a, 2002b) notes that “the high accuracies and expensive professional expertise associated with the cadastre has meant that there is too little cadastral coverage in Africa”. Insisting on expensive standards by professionals does not improve access to land for poor people. A change of attitudes is needed, whereby instead of implementing government and science rules, the focus should be to serve the poor and support them in identifying feasible solutions.

The type of identifiers, of varying accuracies and scales, which a land management system should be able to accommodate are:

- Points, geo-codes (sometimes known as dots on plots), and lines (Latu, N.D.; Davies, 1998; Durand Lasserre, 1997; UNCHS, 1990), in vector or raster format;
- Polygons with fuzzy boundaries (Jackson, 1997);
- Text, including lists of names (Ezigbalike and Benwell, 1994) and unique numbers;
- Parcels -poorly surveyed, non geo-referenced (Törhönen and Goodwin:1998:03-4), and geo-referenced;
- Sketch maps (Törhönen and Goodwin:1998), and photographs, in the absence of any better description (UNECA Expert Group meeting, 1998).

Aside from the property parcels of privately owned registered land, based on work by Davies (1998), Cowie (N.D.), Latu (N.D.), information in the form of thematic polygons of low accuracy should be created showing the location and approximate boundaries of the informal settlement and the customary areas. Lists of leaders (Ezigbalike and Benwell, 1994) in the informal settlement and/or customary areas should be attached to such thematic polygons for the purposes of identifying stakeholders and decision makers who should be involved in negotiating land use and/or land right changes. It is not possible to use the cadastral parcel as the only identifier.

This means that we should represent spatial units, parcels, apartments and buildings in the system as One Point (Text), a set of Lines (no closed polygon), Polygon (low to high accuracy), topologically structured parcels or a 3D Object. Different types of (social tenure) relationships need to be introduced, as well as different types of spatial units. Persons can be Natural Person, Company, Municipality (local government), Co-operation (a group of farmers), Group, Group of Groups, State, Church/Mosque etc.

A person can be member of a group, a group can be member of a group of groups. A person (natural, non natural), a group of persons or a group of groups can have a one or more types of rights or socio-tenure-relationships associated, where each right concerns one or more spatial

units; spatial units can overlap or can be identified with a label. A right or socio-tenure relationship is always in between persons and land. A right can be undocumented, in that case the source document is 'no document'.

The legal and technical system specifications will differ dependent on the purposes of the system (van der Molen, 2003, van der Molen and Lemmen, 2005). Land registrars and land surveyors should design land administration systems that are not more complex and accurate than needed for the purposes that have to be served. This can imply that systems with different levels of complexity and accuracy are introduced for different areas/regions in one territory. It pertains to new forms of rightful claimants, new types of rights or social tenure relationships to land and new forms of spatial units, apart from the classical parcel based approaches.

Finally, land administration systems should be able to accommodate various land tenure arrangements. In essence we show it should be possible to register or maintain records of relationships between people and land irrespective of the nature of the country's jurisprudence; this ability offers opportunities for the integration of statutory, customary and informal arrangements within conventional land administration systems. This paper is an attempt to start to work out some kind of solution.

5. THE SOCIAL TENURE DOMAIN MODEL IN UNIFIED MODELING LANGUAGE

Based on the above, a Social Tenure Domain Model, covering land administration in a broad sense, provides a *extensible* basis for efficient and effective system development. The Social Tenure Domain Model – STDM as a first draft presented in this paper is a specialization of the FIG Core Cadastral Domain Model – CCDM (van Oosterom et al, 2006; Lemmen and van Oosterom 2006). Both the Cadastral Domain Model and the Social Tenure Domain Model are presented in Unified Modelling Language – UML.

The relationship between land and people via rights in legislation is the foundation of every conventional land administration. In the Social Tenure Domain Model it is about the SocialTenureRelation between Persons and SpatialUnits. In the model there is no direct relationship between Person and SpatialUnits, but only via SocialTenureRelations.

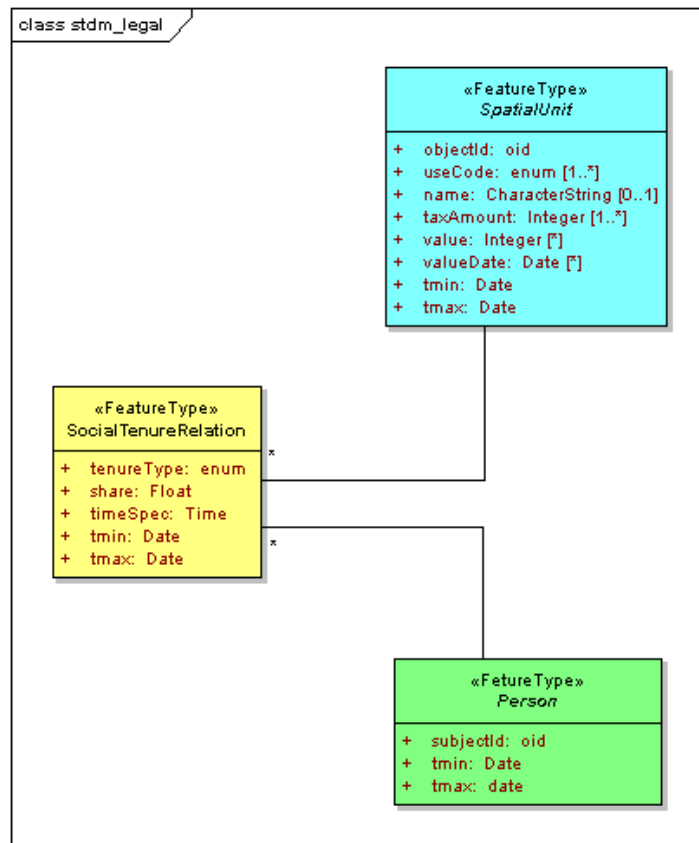


Figure 1: Core of the Social Tenure Domain Model:
Spatial Unit – Social Tenure Relation – Person

Figure 1 shows the core of the model in a UML class diagram. After the analysis of requirements in many countries, specialisations have been developed for the (abstract) classes Person and SpatialUnit as presented in figure 1.

It should be noted that with the Social Tenure Domain Model we do not have the intention to 100% complete representation of all possible cases for one specific country. It is very likely that additional attributes, operators, associations and perhaps even complete new classes are needed for a specific country or region. Further it has to be noted that only a subset of the STDM classes can be used for a specific implementation (depending on the specific scope); there have to be many optionalities, both at class and attribute level.

The STDM contains both ‘administrative’ object classes like Persons, SocialTenureRelations and the ‘geographic’ class SpatialUnit. The model could be implemented as a distributed set of (geo-) information systems, each supporting the maintenance activities and the information supply of parts of the dataset represented in this model (diagram), thereby using the services provided by the systems supporting other parts of the model. The fact that they are based on the same standards make sure that the content of these system is interoperable. Decentralised approaches are very well possible if based on standards. When trying to understand the

model, one should not look at the whole model at once, but at the UML ‘packages’ or coherent parts of the model (each with their own color):

- Yellow: aspects related to Social Tenure Relation, (figure 2a)
- Green: aspects related to Person, (figure 2a)
- Blue: aspects related to Spatial Unit, (figure 2b)
- Pink: surveying aspects and purple: Geometric/Topological aspects (see figure 2c).

Person classes

‘Person’ has as specialisation classes NaturalPerson or NonNaturalPerson like organisations, companies or governmental departments. It should be noticed that a person can hold a *share* in a SocialTenureRelation. Further there can be GroupPerson, see Figure 2a. A GroupPerson is intended to represent communities, tribes, cooperation’s and other entities representing social structures (both legal and non legal). In UML GroupPerson is an aggregation of Person. Note that a GroupPerson can consist of all kinds of persons: NaturalPersons, NonNaturalPersons, but also of other GroupPersons. A GroupPerson should have 2 or more members. Further, a Person can be a member of 0 or more GroupPersons. The aggregate association between GroupPerson and Person could be further described into an association class ‘Members’, in which for each Member certain attributes are maintained; e.g. the share in the group and the start and optionally end date of the membership.

Persons with a specific role in the data collection process are SpatialDataCollector (could be a Surveyor) and Conveyor. Certification, or at least acceptance within the community may be required – for this reason those persons appear in separate classes. The same is valid for MoneyProvider.

SocialTenureRelation

In principle, all SocialTenureRelations are based on Inventories – made up by the SpatialDataCollector and the Conveyor – as source.

Each jurisdiction has a different 'land tenure systems', reflecting the social relationships regarding rights (and restrictions) and claims to land and/or building in that area. The variety of rights, social tenure relations and claims can be quite large within an area where the STDM will be applied. For this reason ‘lookup tables’ are used to catalogue those rights, social tenure relations and claims, an example is give in Figure 2a in the lower right corner. ‘Customary Right’ or ‘Informal Right’ typical for a region can be included. In the lookup table in Figure 2a the following SocialTenureRelations (some of them are formal rights) are included:

Ownership

Apartment Right

Informal Type

Customary Type

Co-operation, this is a form of group rights

Social housing/cooperatives

Tenancy/simple lease
Possession, e.g. in case of squatter invasions
Primary, demarcated and register able leases
Miri
Milk
Waqf (religious land)
Restriction Types
State Property
Disagreement
Conflict
Occupation
Unconventional Privatisation (in the UML diagram Figure 2 this is called ‘uncontrolled’)
Claims against property registered to others –either in occupation of property or not in occupation –post conflict

Note that in an apartment complex (building) there can be a mix of formal ownership for the IndividualUnits and informal ownership for SharedUnits.

A Social Tenure Relation can be recognised as a collateral for a Money Provider. E.g. a micro credit provided by a co-operation or community. This in addition to mortgages provided by banks.

Spatial Units

The SpatialUnits are refined into several groups: the ‘Parcel Family’ (in 2D and 3D, including DescriptiveSpatialUnit, PointBasedSpatialUnit, IncompleteSpatialUnit, SketchPhotoSpatialUnit), the ‘Building Family’ (including Building, IndividualUnit, SharedUnit), SpatialUnitComplex and OtherRegisterObjects. Further there can be Fishing/hunting/thatching grass/right of way rights without specific territory. The ‘Parcel Family’ has been introduced and described in (Lemmen, van Oosterom, 2006).

The idea is that it should be possible to represent parcels not only as faces of a planar (or spatial) partition (that is, a set of areas without ‘overlaps’ and without ‘gaps’), but also in alternative ways. Such alternative Spatial Units could (initially) be represented as a text describing the SpatialUnit (DescriptiveSpatialUnit), as a single point (PointBasedSpatial Unit) or a spaghetti polygon, which is not adjusted with its neighbors in a topological structure (IncompleteSpatialUnit – can have spatial data from different sources and can be topological incomplete) or with the accommodation of graphical (pictorial) data with any spatial reference is missing (SketchPhotoSpatialUnit). This means an area represented in the STDM ‘Parcel Family’ is subdivided into two types of regions:

1. regions based on a planar partition (type PlanarPartitionRegion - PPR), only well defined Parcels can exist in such a region and they have a topological structure; and

2. regions not based on a planar partition (type NonPlanarPartitionRegion - NPPR), in this type of regions other types of parcels can exist: DescriptiveSpatialUnit, PointBasedSpatialUnit, IncompleteSpatialUnit or SketchPhotoSpatialUnit.

In principle PPR and NPPR do not overlap. However, in case of conflict there can be explicit OverlappingSpatialUnits (not part of the normal ‘Parcel Family’ in the UML diagram).

The other Spatial Units (blue) include: Building, Unit and OtherRegisterObject (e.g. overlapping claims or utility networks). All these specialisations of Spatial Unit have associations with one or more Persons via the Social Tenure Relationship class.

A Building is composed out of several Units. A Unit can be used for living purposes, commercial or other. There are IndividualUnits and SharedUnits. The latter corresponding to common areas and facilities.

SpatialUnitComplex allows to relate one right to e.g. a combination apartment Unit, parking place and another Unit in the building.

Surveying classes

Object classes related to acquisition of spatial data are presented in pink color (see Figure 2b). Spatial data collection is documented on a SpatialUnitInventory, which is a source document made up in the field. This document may contain signatures; in a full digital surrounding a field office may be required to support this under the condition that digital signatures (or digital fingerprints) have a legal support. Files with terrestrial observations -distances, bearings, and referred geodetic control- on points are attributes of SpatialUnitInventory, the measurements. The SurveyPoints form the geometric foundation of both the topology-based objects and the non-topology-based objects. Depending on the method of data acquisition survey points can be accurate or less accurate. Enlarged aerial photo's or satellite images can be used to collect survey points –these can be geo-referenced or not. Note that in the STDM it is possible to have multiple coordinates for points, and multiple reference systems are supported. Object classes describing the geometry and topology are included in the STDM, but are not further discussed in this paper, but are based on an earlier paper by Lemmen and van Oosterom (2006).

Time

The temporal aspect is generalised to tmin/tmax and TimeSpec attributes. The tmin/tmax attributes indicate to which system time period a version relates. Nearly every object inherits the tmin/tmax attributes via either the SpatialUnit, SocialTenureRelation or Person. The TimeSpec attribute of the class SocialTenureRelation (and all its subclasses) is capable of handling the user (or valid) temporal representation such as reoccurring pattern (every e.g. every summer, every ...). This supports for example. nomadic behaviour, where pastoralists Have the right to pass a SpatialUnit at agreed periods within a year.

Besides the data modeling aspect of the dynamic processes within the STDM, one could question how the functions and processes are related to each other? The UML class diagram should be further completed by UML diagrams covering other aspects, for example through dynamic (use case, sequence, collaboration, state or activity) diagrams. Activity diagrams show how processes are related to the information (data) and how one ‘flows’ from on to the other. The introduction of different ‘stages’ of a parcel (no spatial component, descriptive text, identified by address or geo-code (one-point), image, surveyed, topologically structured, 3D volume), a right (ownership, primary, demarcated and/or registerable leases) and a person could further reflect the dynamic nature of the system.

Interfaces

The interface objects SpatialUnitMap and SocialTenureFolio support the generation and the management of output products and services. Those classes do not contain attributes in themselves but they allow the option to relate e.g. customer (identifier), date and collectively represent all relevant information. This can be useful in the link to Customers Relation Management, Work Flow Management and financial systems.

6. ANALYSES OF THE PROPOSED STDM DESIGN

The requirements presented below are derived from the paper ‘Social Tenure Domain Model – Requirements from the perspective of Pro Poor Land Management’, FIG Regional Conference, Accra, Ghana, March 2006 in (Augustinus et al, 2006). This paper by Augustinus et al (2006) includes a comprehensive analyses of the requirements, and is used as a basis for the discussion below.

Augustinus et al (2006) state that “a land administration system should include information that covers the whole spectrum of formal, informal and customary rights”.., as well as the continuum of rights suggested by UN HABITAT (2003). In this paper we show that it should be possible to merge urban and rural cadastres in one modelling environment. We also show that *it should be possible to merge formal and informal tenure systems in one modelling environment (system)*. The requirements are supported by the STDM by providing support in the representation of different types of SpatialUnits, SocialTenureRelations and Persons.

Many new reference systems are under development world wide. One example from Africa is AFREF which is a planned surveying reference system for all 53 African countries. The impact of this development, and similar developments in other regions, is that existing co-ordinates in existing frameworks are expected to be able to be transformed to new ‘versions’ of these co-ordinates in the future. This means that it should be possible to represent one point in two co-ordinate systems or maybe even three co-ordinate systems if local (measurement) co-ordinate systems have to also be included. Of course only one co-ordinate pair is the ‘actual’ one, but a conversion from local to existing national to new national reference system is expected to be a requirement which has to be supported. *It should be possible to represent*

spatial data in several reference systems. This requirement is fully supported in the STDM and source data documents related to spatial data collection are supported.

Spatial Data Infrastructure provides an environment where spatial data from different systems can be linked and coordinated. In the past this linking has been proved to be very problematic. Unique object identification is of critical importance (UN, 2004). *Spatial data in land administration systems should be linkable with other systems containing spatial data. There should be optimal flexibility in linking all types of attributes and identifiers.* This is the basic concept behind the STDM: to produce and provide land administration data in a decentralised environment – but based on standards as provided by the model. The model could be implemented as a distributed set of (geo-) information systems, each supporting the maintenance activities and the information supply of parts of the dataset represented in this model (diagram), thereby using other parts of the model. *Supporting a wide range of Spatial Unit identifiers is not yet supported by the current STDM design and will require further research.*

Where information exists, it is often spread among several government departments and accessing it is difficult. Most developing countries, and Africa is no exception, need to reduce the excessively high number of institutions involved in land management and information flows. A land management system should serve decision makers at national, regional and local level, with the emphasis on decentralized decision making. Such decentralization should allow *the creation of better vertical coordination between ‘bottom up’ information and local interest and ‘top down’ information and policy guidance which can harmonize overall national development policy with local programs.* Such an approach would allow the organisational structure to change continuously. *Land administration systems should be implementable in a decentralised and distributed environment – based on standards as provided by the STDM.* This principle is one of the basic concepts behind the STDM: The model could be implemented as a distributed set of (geo-) information systems, each supporting the maintenance activities and the information supply of parts of the dataset represented in this model (diagram), thereby using other parts of the model. The fact that the distributed parts of the system are based on the same model supports the requirement that these different parts fit well together.

Data acquisition is related to accuracy of spatial data. Augustinus et al (2006) state that *“it should be possible to manage spatial data with different accuracies and from different sources.”* The STDM supports this, for example by the class ‘Incomplete Spatial Unit’.

Augustinus et al (2006) state that *“the data should be easy to access and to understand. The land data should be accessible at local level and friendly to the poor, often uneducated people.”* That is, *a user friendly user interface is required.* This is a design criterion during software development. Such an interface can be available in a computerised environment. Concerning *the required support of participatory approaches: the existing STDM is not in conflict with a participatory approach.* It has to be investigated as to whether the inclusion of a class ‘local committee’ (with decision making power) or a class ‘regional committee’ is

sufficient to support the participatory approach. In fact those classes could be specializations of the class conveyor as it is included now in the STDM.

Augustinus et al (2006) state that “..data bases should accommodate a range of identifiers, geo-referenced parcels, un-referenced parcels, lines and points. It should be possible to represent parcels/spatial units as single points, geo-codes (sometimes known as dots on plots), lines and polygons; polygons can have accurate, less accurate or fuzzy boundaries. Parcels/spatial units can be poorly surveyed, non geo-referenced and geo-referenced.” Data bases also have to accommodate the fuzzy boundaries of informal settlements and customary areas. *Representation of a broad range of spatial units* is supported by the STDM and it is easy to extend the STDM if new functionalities are required to support other types of Spatial Units.

Overlapping rights are common in tenure systems. *It should be possible to represent overlapping tenure systems in the STDM.* Conflict situations can be managed using the class `OverlappingSpatialUnit`.

Gender has also been modelled in the STDM.

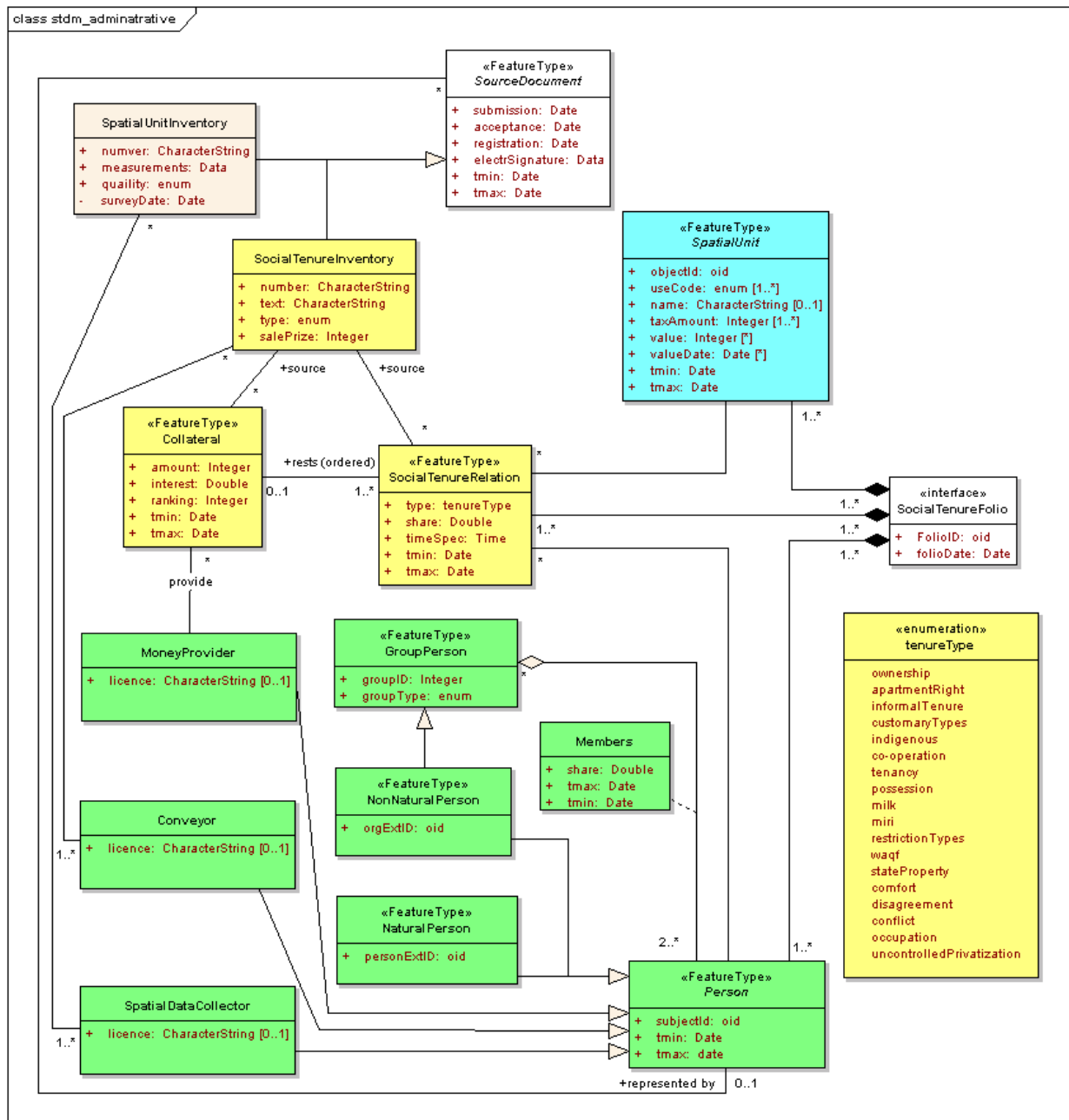


Fig 2a: Social Tenure Relationships and Persons

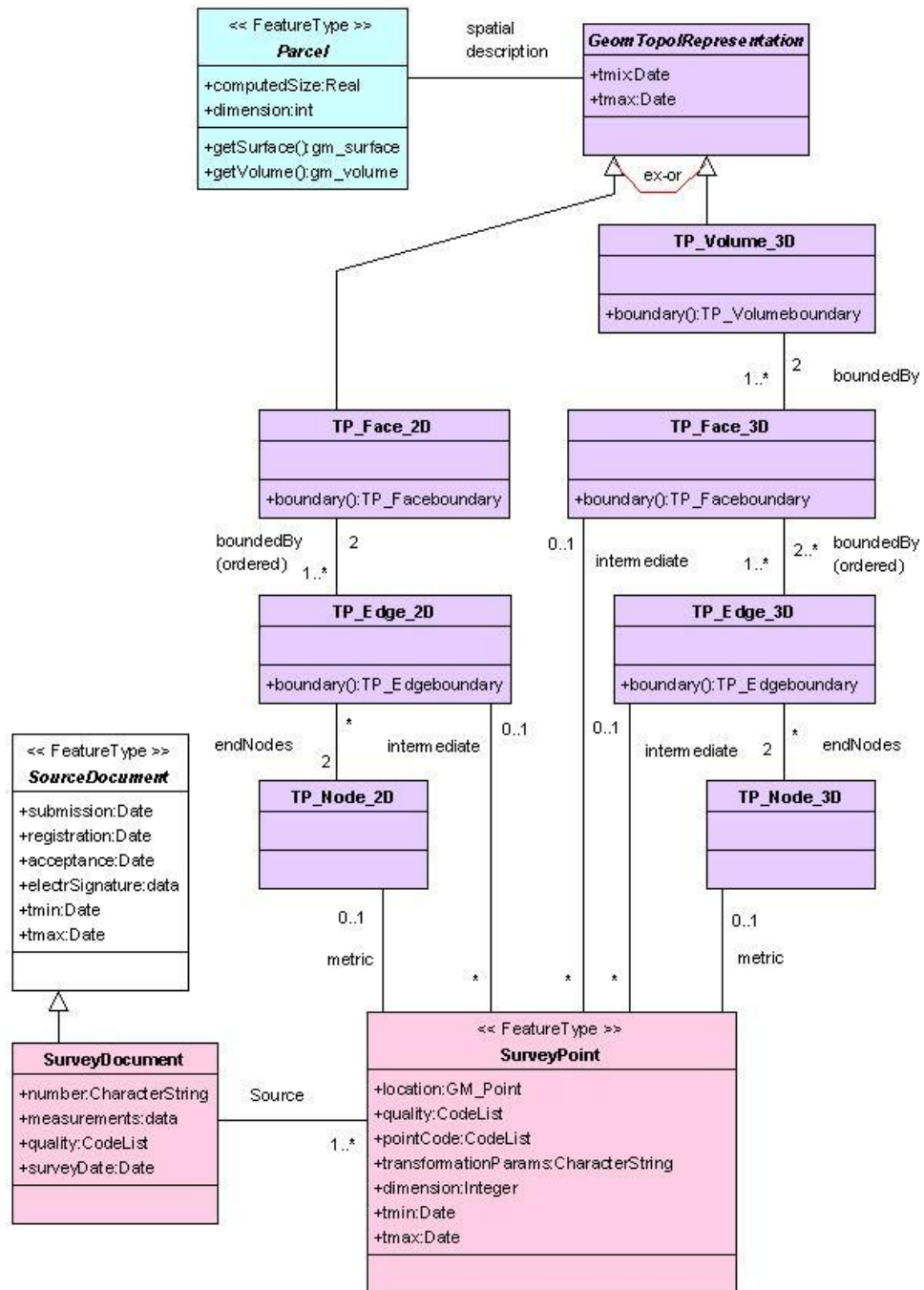


Figure 2c. The Geometry, Topology

7. CONCLUDING REMARKS

A Social Tenure Domain Model (as a specialisation of the Core Cadastral Domain Model) has been developed supporting the data modelling as a basis for system development in the social tenure domain.

Conventional basic concepts of land administration are affected in three ways:

- the Person: group with non-defined membership (note: a person can be a Natural Person, a Company, a Municipality, Co-operation, a Married couple, a Group, a Group of groups, a Ministry, etc)
- the rights: the recognition of types of non-formal and informal rights (possibility to include: Ownership, ApartmentRight (can be formal or informal for Shared Units and Individual Units), Informal Tenures, Customary Types, Indigenous Rights, Co-operations, Tenancy, Flexible Tenure, Possession, Use Rights, Leases (alternative: primary, demarcated and register able Leases), Long Leases, Islamic Rights: Miri – Milk – Waqf; Restriction Types; State Property; (Certificate of) Comfort, Conflict situations (Disagreement, Overlap, Occupation, Uncontrolled Privatisation
- the object: units other than accurate and established units. Apart from Parcel, Apartment, Building, we have shown that it is possible to represent Spatial Unit's as One Point (GeoCoding), a set of Lines, a Polygon (low-high accuracy), topologically structured Parcels or a 3D Volume. Quality labels have to be included for this purpose.

A person (natural, non natural), a group of persons or a group of groups can have a one or more types of rights or SocioalTenureRelations associated, where each right concerns one or more SpatialUnits; SpatialUnits can overlap (in certain explicit cases) and can always be identified with a label. A right or SocialTenureRelation is always in between Persons and SpatialUnits. A right can be undocumented, in that case the source document is 'no document'.

The gender issue has been modelled in the STDM and conflict situations can be represented. The UN HABITAT Continuum of land rights is covered.

Further research is required on the requirements:

- Reversibility to paper. This requirement is not yet really worked out; the so called interface classes SocialTenureFolio and SpatialUnitMap may provide the basis to model this reversibility requirement;
- Support of a wide range of spatial identifiers;
- Overlap in tenure;
- Support in participatory approaches.

The STDM model described above indicates that the wide range of social land tenures in existence, and their requirements in terms of modeling for land management could be modeled.

Finally, this paper has shown that in the further development of a Social Tenure Domain Model land registrars and land surveyors should work together with social scientists, anthropologists and computer scientists to produce a product which can underpin land management in developing and post conflict countries, something which is needed in order to reach the Millennium Development Goals, as well as the goals of a range of countries introducing new innovative approaches.

Note: development of the system supporting the STDM can be done on the basis of Model Driven Architectures. Components of such system could be open source; e.g. the PostgreSQL database. A distributed approach is possible if related to standards as proposed in this paper.

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