Call for partners

FAO intends to support the building of an Open-Source Cadastre and Registration development project and community in the Web, which will allow a peer production development of source code for the software that is made available for public collaboration. As described the developed initial product will be tested with the three real cases in Africa, South Asia and Asia Pacific. The final result, applied modules of Open-Source Cadastre and Registration software with an active user community, aims to lower the barriers for entry level of developing countries to use IT for improving land registration systems and the security of tenure. FAO welcomes all interested parties to join the community of Open-Source Cadastre and Registration software initially by emailing interest to mika.torhonen@fao.org.

3.5 The Social Tenure Domain Model – A Pro-Poor Land Rights Recording System

Christiaan Lemmen, Clarissa Augustinus, Solomon Haile, Peter van Oosterom

In developing countries, large portions of land remain untitled, with less than 30 % of cadastral coverage conforming to the situation on the ground. Where there is little land information, there is little land management. Conventional land information systems cannot adequately serve areas that do not conform to the land parcel approach applied in the developed world. As a result, a more flexible system is needed for identifying the various kinds of land tenure in informal settlements. This system has to be based on a global standard and has to be manageable by the local community itself. Enter the Social Tenure Domain Model. STDM is intended to introduce new, unconventional approaches in land administration by providing a land information management framework that would integrate formal, informal, and customary land systems, as well as integrate administrative and spatial components. The STDM makes this possible through tools that facilitate recording all forms of land rights, all types of rights holders and all kinds of land and property objects/spatial units regardless of the level of formality. The thinking behind the STDM also goes beyond some established conventions. Traditional or conventional land administration systems, for example, relate names or addresses of persons to land parcels via rights. An alternative option is being provided by the STDM, which instead relates personal identifiers, such as fingerprints, to a coordinate point inside a plot of land through a social tenure relation such as tenancy. The STDM thus provides an extensible basis for an efficient and effective system of land rights recording.
The STDM development activity has generated conceptual, functional and technical designs. The prototype is under development at the International Institute for Geo-Information Science and Earth Observation (ITC) in close co-operation with Global Land Tool Network/UN-HABITAT and the International Federation of Surveyors (FIG).

The STDM Concept can of course be implemented in both commercial and open-source GIS and database management software or combinations of both.

In this chapter it is illustrated that new, unconventional approaches need to be supported, combined with a data acquisition based on imagery. A prototype software is presented with a first field test results.

The STDM Concept

The Global Land Tool Network (GLTN) aims to establish a continuum of land rights, ranging from non-formalised or recorded rights at all to full property rights, with all possible variations in between. This means informal rights such as occupancy, adverse possession, tenancy, use rights (this can be formal as well), customary rights, religious rights and indigenous tenure, as well as formal rights, are recognised and supported (with regard to information management) in the STDM-enabled land administration system.

The main aim of this is to come to a more just and equitable system of land management that benefits all people. The existence of a continuum does also exist for the other core components in land administration: parties and spatial units. This was recognised in two papers presented at conferences from the International Federation of Surveyors (Augustinus et al, 2006; Lemmen et al (2007). Parties can appear as natural or non-natural persons or governments as in conventional land administration but also as tribes, group persons, families etc. Spatial Units concern the area’s where land rights or social tenure relationships appear. The Spatial Units can be overlapping in case of overlapping claims. The representation of Spatial Units in a land administration has a wide range of options, from no representation at all, to a description in text of the location of the boundaries, to points, sets of lines or polygons identified from aerial imagery or field surveyed.

This approach has an impact on the traditional or conventional basic concepts of land administration. They are affected in three ways (see Table 3.2).

A party (person, non person), a group of persons, or a group of groups can have one, or more types of rights, or social tenure relationships associated, where

---

33 The Global Land Tool Network (GLTN)’s main objective is to contribute to poverty alleviation and the Millennium Development Goals through land reform, improved land management and security of tenure. The GLTN originates from requests made by Member States and local communities world-wide to the United Nations Human Settlements Programme (UN-HABITAT), who initiated the network in cooperation with the Swedish International Development Cooperation Agency (Sida), the Norwegian Ministry of Foreign Affairs and the World Bank, in 2006.
The Party

an individual, or a group with an explicit, or implicit definition of membership. Therefore, a Party can be a natural person, a company, a municipality, a co-operation, a married couple, a group, a group of groups, or a ministry, to name some examples.

The Social Tenure Relationship

(the right or “relationship” between parties and spatial units)

the recognition of types of non-formal and informal rights (possibly to include: ownership, responsibilities and restrictions, apartment right – which 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, such as primary, demarcated, and registerable leases).

long leases, Islamic rights: miri – milk – waqf; restriction types; state property (including public restrictions), (certificates of) comfort.

conflict situations: disagreement, overlap, occupation, uncontrolled privatization.

The Spatial Unit

units other than accurate, and established units. Apart from parcel, apartment, and building, we have shown that it is possible to represent spatial units as a single point (geocoding), a set of lines, or a polygon (with low or high accuracy), also topologically structured parcels, or a 3D volume. Quality labels have to be included for this purpose.

Table 3.2: Impact of STDM on Conventional Concepts in Land Administration.

- each right concerns one, or more spatial units; spatial units can overlap (in certain explicit cases) and can always be identified with a label. A right, or social tenure relationship is always between Party and Spatial Unit. It may happen that a social tenure relationship is only documented by recordation, that means without formal source documents. The gender issue has been modeled in the STDM, and conflict situations can be represented. The UN-HABITAT continuum of land rights is covered.

- The UML (Unified Modeling Language) Class diagram is presented in Figure 3.3. Apart from Parties, Social Tenure Relationships and Parties it also includes classes to represent Source documents and Survey Points.

### Data Acquisition for STDM

In an STDM-enabled land administration, data from diversified sources is supported based on local needs and capabilities. This pertains to both spatial and administrative (non-spatial) data. For example, in informal settlements there may be sufficient information to relate people-land relationships to a single point. Attributes such as photographs and fingerprints can be attached to the records. A cadastral map may be derived from satellite images and combined with descriptions of rights and rights holders. Using satellite images in the field can be considered as a pro-poor and participatory approach. People can “sit around the image” and point the location of the land-use boundaries in the field. Extra observation
collected with simple GPS devices may be included. The STDM encourages and caters for all these variations within a standardised environment.

High-resolution satellite imagery is one of the emerging and very promising sources of spatial data for land administration. A large-scale plot of such images can be used to identify land over which certain rights are exercised by the people themselves, in a participatory manner. As proof of the concept, the World Bank, with GLTN funding, organised and led an exercise in Ethiopia in June 2008 which included preliminary tests on the feasibility of high-resolution satellite images for land records. The results of this experiment are encouraging. Similar initiatives in other countries like Rwanda are also yielding comparable outcomes. Figure 3.4 shows the data collected in the field. Figure 3.5 gives the result of the fieldwork:
identified boundary data. This can be considered evidence from the field; neighbours were represented as well as village officials. The digitised boundary data resulting from this exercise can be seen in Figure 3.6.

**STDM Prototype**

The Social Tenure Domain Model (STDM) application is currently a client/server application that has been developed using open-source software. The application requires PostgreSQL (Database Management) and Tomcat (to organise a Client Server environment) at the server side and ILWIS (Integrated Land and Water Information System) on the client side. This system supports the raster data management very well. All standard software is open-source. The STDM prototype runs on top of ILWIS.

The software is rather flexible, which can be applied independent from the way work flows are organised. This is an important achievement, workflows are not easy to standardise because of the different institutional and organisational settings of land administration – also where social tenure is concerned.
Figure 3.5: Collected field data on satellite image.

Figure 3.6: Printscreen with vectorized boundaries in STDM Prototype based on ILWIS.
STDM Functionality

The final version of the STDM Prototype contains the functionality to support the processes as described above, mainly:

- Plot images for data collection; this is the basis for collection of boundaries of spatial units in the field
- GPS data input; easy combination with the raster data from the images
- Scan images; the collected evidence from the field is scanned. In this way a digital access to source data is possible.
- Vectorise the drawn boundaries
- Link spatial and administrative data: the prototype has functionality to insert and manage data on Parties, Spatial Units and to link them in Social Tenure Relations
- Manage history: it’s possible to introduce timestamps for all objects; this allows to “look back” in time
- Source documents; all inserted data should be derived from source data (images, forms)
- Insert names of data collectors; the responsible employees are linked to the data in the database.

The STDM Prototype (see Figure 3.7) can be used independent from the way transaction processes are organised. The software supports the insertion, change

Figure 3.7: STDM Main window.
or deletion of parties, social tenure relations and spatial units. Shares in social tenure relations between people (parties) and land (spatial units) are possible. New types of social tenure relations can be included in a code table, which allows for a very flexible approach.

**STDM Field test**

A first cycle in the prototyping has been tested in user environment in the field test in Ethiopia. Some of the observed shortcomings have been repaired and are available in the version delivered at the end of December 2009. The following observations can be made in relation to this test.

The installation of the software components in its Java, POstgreSQL, Tomcat, ILWIS and the STDM application in combination with the creation of the database is of a complex nature – even with an installation guide available.

Transaction management. This is included in STDM in an implicit way. Transactions like splitting and merging spatial units are supported, as well as buying/selling or inheritance. There have also been discussions on other transaction issues:

- How to go from informal social tenure relation to a formal one? And from a personal use right to a formal one? The inventory of informal rights is a “what to do list” for the government.
- How to move from a conflict situation (conflicting claims) to a formal one? Again a “what to do list” for the government – upgrade the rights or take other decisions based on the recordation of rights.
- How to protect women’s access to land – this can be organised by using shares in rights. This is supported as an attribute share in STDM, but the required calculations to make the sum of the shares equal to one is not yet available. Question: can there be religious based regimes in the same territory?
- How to organise a split combined with a merge?

The co-ordinate system – need to move to WGS84; then the link with satellite images and GPS is easy to make.

Adjudication not in the field but in a room where all inhabitants (right holders) are together; projection from a computer by beamer on a screen. Villagers can identify the boundaries on the screen, the boundary can be vectorised on top of the raster image. This is in conflict with the principle of collecting evidence in the field. In any case this approach was successfully demonstrated in Bahir Dar and discussed.

Public inspection (after all data have been collected and digitised) based on the same approach. This means that the people from one area are together in a room; projection of the results of adjudication from a computer by beamer on a screen. Villagers can recognise the boundaries on the screen, if everyone agrees it can be given status “agreed”. There can be geo-referenced scanned images with field
work results under the image or the paper plots can be used to vectorise directly. This means dispute resolution on a transparent and participatory basis. This was not worked out in Bahir Dar, but is an impact of the proof of concept as described above.

A main issue is further the organisation of the first data input. This can be organised in many different ways; with different responsibilities for different people. The same for digitizing the data after being collected in the field. Depending on the way the data acquisition is organised the digitizing can be organized in different ways. For this reason different roles are available in STDM. See Google spatial data, some surprising example cases from Ethiopia. The available data set on Google Earth for Ethiopia has a very good quality. Better then expected by the experts.

The role of source documents. In principle all adjudication observations should be recorded on paper or digital. But the paper based approach seems to work best.

Holdings (of groups of spatial units) by the same party with the same right or social tenure relation and the identification of spatial units. If the complete holding gets an identifier (the same for all spatial units) the identification is complex. If one spatial unit gets the ID of a new holding (and the remaining part of the selling holding remains the same) then different appearances of the same holding have the same identifier, this is confusing. A parcel based approach avoids such problems. Or, new holding identifiers in case of sub-divisions (always combined with merge in case of holdings, except if the buyer represents a new holding). This is again complex. In Bahir Dar the opinion was that holdings should be supported.

ICT security and back up is most relevant. In case the computers are connected to the Internet a virus scanner is needed. This requires a connection where updates for the virus scanner can be easily downloaded.

**Next Steps**

New versions of the components (the database, the GIS, the Client/Server support software) have to be tested in an integral way (so: if there is a new version of Tomcat then the complete software application (the STDM) should be tested. This is well known, the same is valid for the use of commercial software.

An open-source community still has to be established where further software developments and exchange of source code can be organised.

Raster data is big, sometimes huge and often enormous. On the other side the bandwidth of any network is limited; same with processing power of any computer is limited. The problem is that transferring raster data costs time, raster file size should be minimal for that reason:

- Unless strictly needed use byte images.
- Color images use 3 to 4 times as much bytes as byte images
• What resolution is really needed? Using larger pixel size quadratically lowers the size of the dataset.
• Subdivide large datasets into smaller sets that are still practical to use.
• STDM poses no limits to the size of data but
• Data is often transferred over the network so the smaller the sets the quicker this works.
• Some operations are done on the data. Again, the smaller it is the quicker it works.
• Storage server side is big but even the biggest servers can run out of disk space when many big datasets are used.
• Reference maps must be in ILWIS format.

The size of the images should be reduced to the minimum can be managed by the available hardware. Further it is recommended to standardize the spatial reference system for raster data. Further: the selection of data is not an easy job, same for composition of mosaic – without clouds. Local expertise is required. The trend is that raster data become faster and bigger available than can be supported by the processor capacity. Also the storage management should not be forgotten. Files with 20,000 by 30,000 pixels are normal. In Client/Server environment this has impact on the bandwidth. Processing power is limited in many cases. Data sets should become as small as reasonably possible. Colour images do not contain extra information for many applications. Large images should be subdivided before use (not compressed). Transformations of pixel based data sets are of a sensitive matter: one should know the impact. ILWIS is proven to be supportive in raster data management, for this reason this tool is selected for STDM.

**Concluding remarks**

The STDM is a flexible concept which has the capacity to introduce unconventional approaches in land administration. A user-friendly prototype software has been developed allowing to demonstrate this approach has been developed and is available in a second version. The prototype is based on open-source components: Postgres as database and ILWIS as GIS. The software runs in a Client Server environment. The STDM concept can be developed on many platforms, GIS and database management software: commercial or open-source or combinations.

**Further Reading**


Fourie, C., R. Groot, and P. van der Molen (2002). Land management, land administration and geospatial data: exploring the conceptual linkages in the developing world, Geomatica 56 (4).
