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Universal Land Registry to Support Independent Economic Development in Tanzania*

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Abstract

A simple land property registration procedure cannot be taken for granted in Tanzania. Nevertheless, it is crucial for private investment and wealth accumulation in one of the poorest countries in the world. To improve the formal land registration procedures is currently one of the topmost items on the agenda of the Tanzania Government.

To help speed up the technical implementation of an improved land registration procedure, a group of volunteers – GIS experts and students from Europe and North America – elaborated the solution design for a Universal Land Registry (ULR) application. A prototype implementation demonstrates the feasibility of the solution with Open Source Software.

The solution design with use cases, data model and solution architecture is presented in this paper. Furthermore, some implementation considerations are made to support the distributed nature of the different partners involved from land use planners at national level to the individual land owner on his or her plot. In particular, different requirements related to data quality (spatial precision, completeness etc.) are considered for a viable solution in such a vast country like Tanzania. As land use and land ownership information is core information for a National Spatial Data Infrastructure (NSDI), a close organizational and technical integration of the ULR with all efforts to construct a NSDI is envisaged.

Keywords: Tanzania, cadastre, land tenure, land rights, Universal Land Registry, land use planning

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1 INTRODUCTION

A recent in-depth study commissioned by the Government of Tanzania (de Soto 2006) revealed that only 11% of the land properties in Tanzania are legally registered. The value of extralegal Tanzanian assets is estimated to US$ 29.3 billion, capital that goes largely underutilized due to the lack of protection by the Government. Creating the legal and organizational framework to turn this "dead" into "liquid" capital to make it accessible for private investments and for taxation is therefore high on the agenda of the President.

To provide land tenure security is highly complex in Tanzania where different legal systems overlap, where the registration of a parcel might take up to 8 years and where regulatory intervention is seen as a means to dispossess vulnerable groups. Nevertheless, proof of ownership of land is accepted as a vital need for development, thus the extralegal economy developed several independent ways to document land ownership and transactions. Not surprisingly, costly land disputes are frequent, yet the extralegal documents are of limited value to obtain mortgages and credits. Land tax collection is in disorder depriving the Government of the resources to build an effective system of land registration to provide land tenure security, a vicious circle.

Simple solutions are not at hand. A consolidated procedure to develop the one solution considering all legal, organizational and technical aspects as well as all parties involved is only a distant prospect. Know-how to build an IT (Information Technology) and GIS (Geographic Information System) supported land registry is very limited. In this context, a group of students and lecturers at several universities took the initiative to design a system architecture for a universal land registry (ULR) that can be deployed independently of the political process to develop a new framework for Government assured land tenure.

The main purpose of the ULR is to collect, capture, organize and track all kinds of land right information with a geographic reference. Based on the "Cadastre 2014" proposal of the International Federation of Surveyors (Kaufmann & Steudler 1998) a data structure is developed to register the rightful claimant (owner), the legal land object and the related land right. The solution considers that the proper identification of subjects, rights and land objects is difficult but crucial in the Tanzanian context: only a fraction of the 36 million inhabitants possesses a passport or identity card, land tenure information is kept on 40,000 survey plans for the legal records (Silayo 2005) and in more than 10,000 different locations for extralegal records (de Soto 2006). The ULR therefore has to consider the highly distributed nature of land tenure information and to provide means to register people (fingerprints, photographs, signatures), land (GPS, aerial photographs, topographic maps, georeferencing functionality) and documents describing land

rights (scanner). The registration of all this information has to be done in the framework of proper land use planning. A spatial data infrastructure to support this endeavour not only has to provide tools to develop land use plans just in time for each land registration exercise in a village, but it will also grow and improve with the information registered by land owners.

The ULR caters for heterogeneous land information. Experience from other countries shows that land information consolidation can take several generations. Not only will the ULR evolve together with the legal and organizational framework, but it will also provide most valuable information for other sectors like regional planning, environmental protection and infrastructure management.

2 PROBLEM OUTLINE

2.1 Legal Framework

Kironde (2006) provides an excellent overview of the history and the current state of land property rights issues in Tanzania. According to Kironde, the first formal land registry was introduced during the German era in 1903. The 1903 Land Registration Ordinance was replaced in 1923 by the British Land Ordinance which in essence continued to be the principal legislation on land tenure until 1999. Since 2001, the Land Act 1999 and the Village Land Act 1999 officially determine land use and land tenure in Tanzania. The new land laws declare all land as “public land vested in the President as trustee on behalf of all citizens” (Land Act 1999, section 3). Though, there is no private property in land in its proper sense, the new land laws initiate a shift towards a market orientated land policy. They ensure the recognition of existing customary land rights and foster the improvement of the existing land management system (Derby 2002). The following land types are distinguished:

- reserved land (e.g. protection areas);
- village land, which falls under the jurisdiction and management of a registered village; and
- general land, which is neither reserved land nor village land e.g. all urban areas.

Land titles are issued as “Customary Right of Occupancy” in village land and as “Granted Right of Occupancy” within general land or reserved land (Larsson 2006). Customary land rights still play an important role in local land management. The local administration practices depend hereby on the cultural background of the people and the natural conditions of the area. Migration and mixing of cultures leads consequently to a diffuse conglomerate of land right arrangements. The parallel existence of indigenous customary rights, customary

rights of immigrants, rights allocated through village authorities, borrowed or rented land right, land rights gained through commercial transactions and registered granted rights is characteristic for Tanzania. Overlapping claims on land are frequent and induce land disputes.

The Tanzanian society is in a (slow) transition from customary rights to a right of occupancy system accompanied by its moving from the tradition of oral adjudication towards written documents concerning business and property issues. De Soto (2006) lists various archetypes of proofs of land use rights like adjudication, registration or collateral. Furthermore he observes extralegal adjudication processes and administrative acts at village meetings. The fact that only 11% of the land occupation rights are formally registered indicates the failure of governmental procedures for the registration of land occupancy rights in Tanzania in the last one hundred years. First of all, there is a "need to inform all stakeholders about their rights and obligations, so that they can effectively participate in [the] implementation [of the Land Act and the Village Land Act]", as is stated on the Tanzania National Website (2008). The current situation is highly uncomfortable for most stakeholders:

- Official procedures to obtain certificates of occupancy are complicated, long, costly and prone to corruption.
- 89% of the property rights are not formalized and thus cannot be used as a security for mortgages and credits (dead capital).
- Land tax collection is in disorder depriving the Government of the resources to build an effective system of land registration to assure land tenure security – a vicious circle.
- The rapidly increasing number of land disputes is an indicator for the increasing interest in land ("the wheel cannot be turned back") and probably also for the far too complex land laws.

If it was not for two consecutive Presidents that not only put land issues high on the agenda but also engaged personally in finding solutions, the situation would be deemed hopeless. The Government of Tanzania is well aware of the extralegal economy.

2.1 Property Formalisation

Following the analysis by Hernando de Soto's Institute for Liberty and Democracy (ILD) (United Republic of Tanzania 2005), the Tanzanian Government with the financial support from the Norwegian Government formulated the "Property and Business Formalisation Programme", also known under the acronym of its Swahili name "Mkurabita" (cf. PBFP). The key idea of the land property part of the programme is to "make it easier to get clear land rights and to transfer them"

(Hakikazi Catalyst 2007). After the “Diagnosis Phase”, which terminated in 2005, the need for a “low cost registration procedure with a geographical database” (de Soto 2006, p. 56) was formulated. As a result of the subsequent “Reform Design Phase” (2006 – 2007), the following objective was formulated:

“To set up a unified and decentralized registry system, that secures legal warranties of registered rights, is easily accessible, operates coordinated with the existing land registries [...] and is provided with simplified and low-cost procedures that facilitate and thereby encourage not only first registration of titles but also registration of subsequent transactions.” (NPA 2006, p. 9)

With their international background in GIS consultancy, implementation and research, a group of GIS and IT professionals felt challenged by this objective to design an easy to use, yet state of the art IT solution for the benefit of Mkurabita. Today, sophisticated cadastre systems can be found in most developed countries. Their main function is to support an active land market by permitting land to be bought, sold, mortgaged or leased. It is increasingly accepted especially in developing countries that modern Land Information Systems (LIS) based on land cadastre are a basic infrastructure for economic development and environmental management (Williamson 1997). The development of cadastral systems towards LIS follows the FIG recommendation ‘Cadastre 2014’ (Kaufmann & Steudler 1998; Kaufmann 2002). Williamson (1997) clearly states, that the debate about cadastre systems is moving from whether cadastral systems are necessary to what is the most appropriate cadastral system for a particular country.

A cadastral system for Tanzania has therefore the task to administer all forms of land tenure established in the land laws. Given the complexity of land related rights, the description of the various relationships of people and land is essential. Lemmen et al. (2007) recommend in such contexts the modelling of the relationship between people and land independent of the level of formalization and legality as proposed in the Social Tenure Domain Model (STDM) (Augustinus et al. 2006; Lemmen et al 2007) which is a specification of the FIG Core Cadastral Domain Model (CCDM) (Lemmen & Van Oosterom 2006).

The project group was convinced that if the “lessons learnt” when introducing geographic database technology in local, regional and national government agencies were applied in the Tanzanian context, a simple but most useful solution for the Tanzanian Government could be designed. And what can be better for a good idea than a real world problem at hand on which to prove its value?

2.3 The Role of Geographic Information Technology

In principle, implementing an IT solution for the public sector in Tanzania should not be much different from doing the same elsewhere in the world. Better yet, an implementation of a land registration application in Tanzania could learn from other countries, thus avoiding the detours they naturally made as precursors. In Switzerland, for example, the official survey procedures have been redesigned in the late 1980ies and early 1990ies for the support by computer systems. The related laws and ordinances were put in place in 1993, and 15 years later, 85% of the settled areas are documented in a standardized way in modern information systems. Parallel to this effort by the surveying sector, land property records systems were computerized resulting in 5 major systems being used in the 26 cantons. Sure, the land related sectors were affected by this effort, but it passed nearly unnoticed by the public at large. The modernization of the survey cost approximately CHF 1 billion. The maintenance of the cadastre and land registry is financed by the fees charged on land transactions. Similar experiences were made elsewhere. The major insights gained are similar to the ones of Switzerland, namely that the first registration is the most expensive part, that ICT solutions for land registration have to cater for local differences and that an established land registration system can best be financed through transaction fees.

In this process, the implementation of new IT systems for surveying and land registration was just an accompaniment to substantial changes in the organization of governmental services. The undisputed geographic information on land use and land ownership helped additional governmental bodies particularly related to planning, infrastructure management and the environment in reorganizing their procedures. Federal and cantonal governments established GIS coordination bodies to simplify the sharing of geographic baseline data. Data exchange and interoperability standards were defined and implemented. The modernization of the land information management was a huge investment, but today, Swiss governmental administration could not do without the geographical data infrastructure created in this effort.

It is assumed that geographical information technology will play an equally important role in the Tanzanian Property and Business Formalisation Programme for the following reasons:

- Record keeping to the extent expected in the Programme cannot effectively be handled without information technology. Furthermore, the IT solution can be built with proper traceability, so as to avoid the all too human by-products of a manually organised registry of such economic importance.

- Georeferencing all existing records about land rights will pinpoint conflicts at once. This immediate “geographic feedback” should best be given directly to the claimant and not be mediated by a GIS operator far away in the capital.
- The positive side-effects of building a computer-based land registry mainly for planning, infrastructure management and the environment would be untapped, leaving the Programme with a suboptimal net present value; in other words: Mkurabita without well-organized GIS and IT support would be yet another expensive chance missed.
- Geodatabase technology has matured and powerful solutions even mostly built on Open Source modules are operational. The costs for the IT solution are therefore insignificant in view of the overall costs of the Programme.
- Today, good IT solutions are built to serve a purpose independent of the organisation. Therefore, with a good solution design a land registry application can be built even though the final land rights registration procedures are not yet established.
- A well-organized, standardized land records management based on GIS technology creates trust for private investment and wealth accumulation, a crucial ingredient for sustainable economic development.

What is lacking most in the Tanzanian context and was therefore provided by the volunteer researcher from Europe and North America is the know-how to design such an ICT solution. The following sections of the paper give an overview of the design artefacts developed for the ULR and related SDI elements following standard ICT methodology.

3 DESIGN OF THE UNIVERSAL LAND REGISTRY APPLICATION

3.1 General Concepts

Widespread ideas about land rights management by the Government are:

- An IT solution can only be built once all legal and organisational questions are clarified and all stakeholders were given a chance to bring in their wishes and requirements.
- A cadastre solution must be perfect with firm demarcation of parcel boundaries and precise surveying.
- GIS solutions are expensive, distributed and federated GIS solutions are even more expensive and non-experts would not be able to operate them.

These ideas prevent consultants and decision makers from even considering a state of the art IT solution for land rights registration in Third World countries. The design of the universal land registry (ULR) aims at disproving these ideas, because there is enough evidence from operational systems that they are wrong.

According to best practices, it is assumed that an IT solution to help solve the problem at hand should have the following features:

- The ULR has to support the process of political and organisational development needed to establish a viable property rights formalisation procedure in Tanzania.
- The ULR has to document all known facts about land use and land property rights including information about the quality and reliability of each fact.
- The ULR has to be reliably operational under real world conditions, i.e. offline and federative capabilities have to be supported by design and user interfaces have to be kept as simple as possible.

The following general concepts are respected in the solution design:

- The core of the solution is a geographic database:
  - A generic data model accommodates all kinds of georeferenced land rights information including amongst others an unambiguous identification of the owners and claimants of the right (e.g. ID, photograph, fingerprint etc.), a documentation of all kinds of proofs for a right (e.g. scanned documents etc.) and a description of the quality and legally binding nature of the recorded facts.
  - The localisation of the ownership right has to support a wide range of possibilities from a rough placement of a point accompanied by photographs from the field, scanned drawings etc. up to a precisely surveyed parcel. Documentation of claims and conflict management will be primordial in the beginning with an evolutionary path towards unambiguous land tenure documentation.
  - All transactions clearly identify who carried out the transaction when, on which system etc. (traceability).
  - Replication mechanisms are implemented to securely propagate transactions from local to district to regional and national level and back with protection against tampering.
- An separate independent user management system with the usual AAA functionality authentication, authorisation and accounting controls all access to all ULR applications:
  - The user management system is distributed so as to support offline access and local user management.
  - The AAA information is regularly replicated between all nodes of the system.
  - The user management system provides a redundant source for the traceability of all transactions.
- The end-user application will support not more than exactly the use cases needed to fulfil the tasks around land rights registration:

- The server based data management will free end-users from all data organization tasks, the most vulnerable part of a geographic information system. The only data related task could be the identification of files for the upload of photographs.
- The end-user workplace is equipped with all relevant hardware for the documentation of land rights like a document scanner, a digital camera, a fingerprint reader, geolocalization equipment etc.
- Redundant documentation of all transactions is assured by systematically producing printouts for all parties involved.

3.2 Use Cases

All design artefacts for the Universal Land Registry are produced using the Unified Modelling Language (UML). Schär (2008) documents use cases for the ULR application to estimate the implementation effort and to identify the functionality for a prototype implementation. Mithöfer (2008) presents activity diagrams which emphasise the interaction between all actors for the processes in data collection and content verification. Here, only a brief overview can be given.

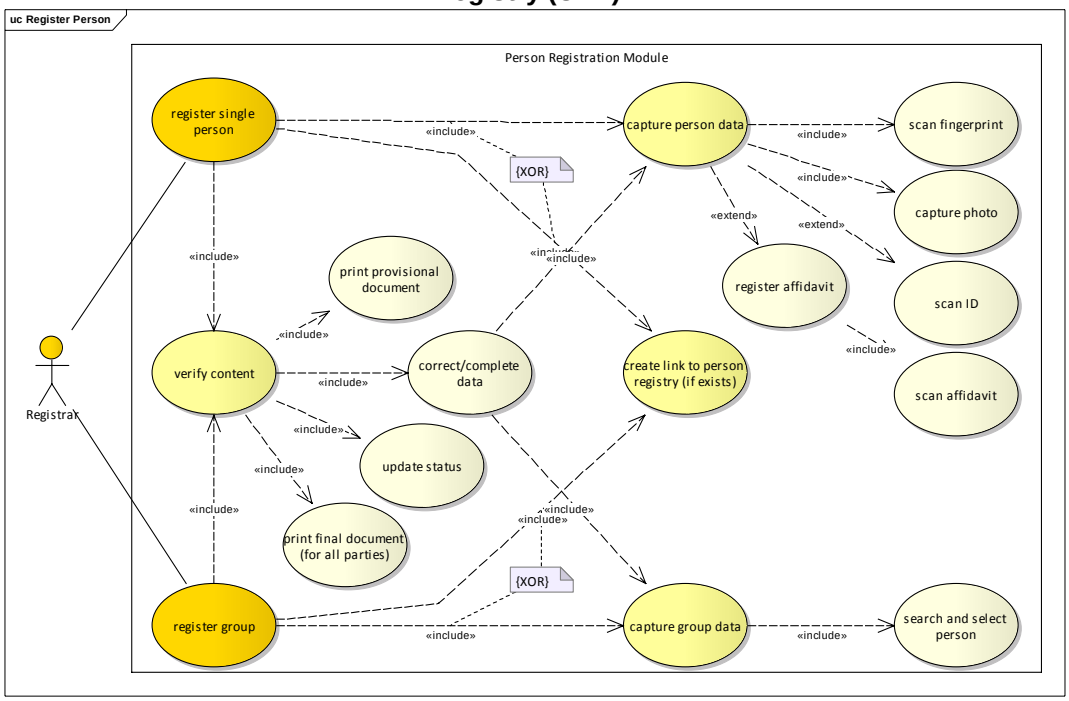
A use case describes the interaction of a user with a system. Though, most workflows include manual and system supported steps, for the design of the computer system the focus is on the steps the user would like to do on the computer.

For the universal land registry, the following groups of system interactions were identified:

- data capturing
- transaction management
- registry enquiry
- system administration

Figure 1 shows the use cases for the registration of persons who claim a land right. The ULR supports the registration of persons as natural persons, legal persons (institutions, corporations) or groups as outlined in the Social Tenure Domain Model (STDM) by Lemmen et al. (2007). Due to the fact, that most Tanzanians do not possess an ID or passport the registration has to be backed up by digitized photographs and fingerprints and if available the provision of an affidavit, all attached to the respective person record.

Figure 1: Use Cases for the Person Registration Module of the Universal Land Registry (ULR).



UC register single person: Registers a single person (natural person or institution) with the ULR. This is accomplished by capturing the person's data (address, fingerprint, photo, passport information, affidavit etc.) or by creating a link to an external person registry.

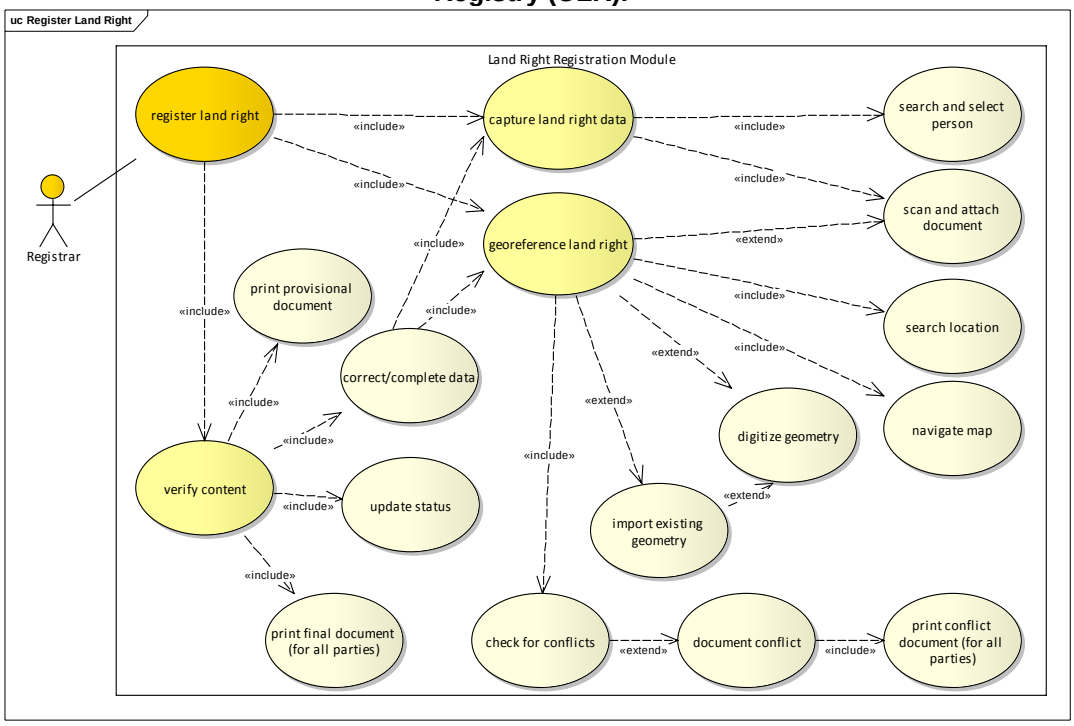
UC register group: Registers a group (a group of persons) with the ULR. This is accomplished by capturing the group's data (name, type etc.) and identifying reference persons (previously registered with the ULR) for the group or by creating a link to a person registry.

UC verify content: All the data entered by registering a person or a group needs to be verified via several methods (affidavit, send confirmation letter etc.). Therefore the ULR application provides means to fulfil this task. Once a new record is verified (and - if necessary - corrected), its state in the ULR is updated, a final document for all involved parties is printed and handed out.

Figure 2 describes the use cases to capture the data for a land right record including georeferencing and conflict detection. The registration of land rights can be based on legal documents, existing cadastral data, extralegal documents or even orally documented customary rights. Customary land rights will be

adjudicated through the local administration to produce formal documents. Existing land right documents will be catalogued and classified, scanned and transferred to the database. For the geographical reference of a land right record, besides the traditional expensive and time consuming surveying methods, new forms of referencing data like the use of remote sensing images or handheld GPS devices have to be supported. The procedure should be flexibly adapted according the surveyed area (e.g. high value crop farm land, informal settlements in urban areas, small scale farm land), available data sources (e.g. aerial photos, high resolution satellite images) and the type of land right (e.g. parcel-based right of occupancy in a residential area or grazing rights without exact boundaries).

Figure 2: Use Cases for the Land Right Registration Module of the Universal Land Registry (ULR).



UC register land right: Registers a land right with the ULR. This is accomplished by capturing land right data (description, land right type, supporting documents etc.) and by georeferencing the land right. Several georeferencing methods are provided (digitizing on various base data, importing existing geometry etc.). Possible land right conflicts triggered by the newly registered land right are immediately displayed and printed out for all involved parties.

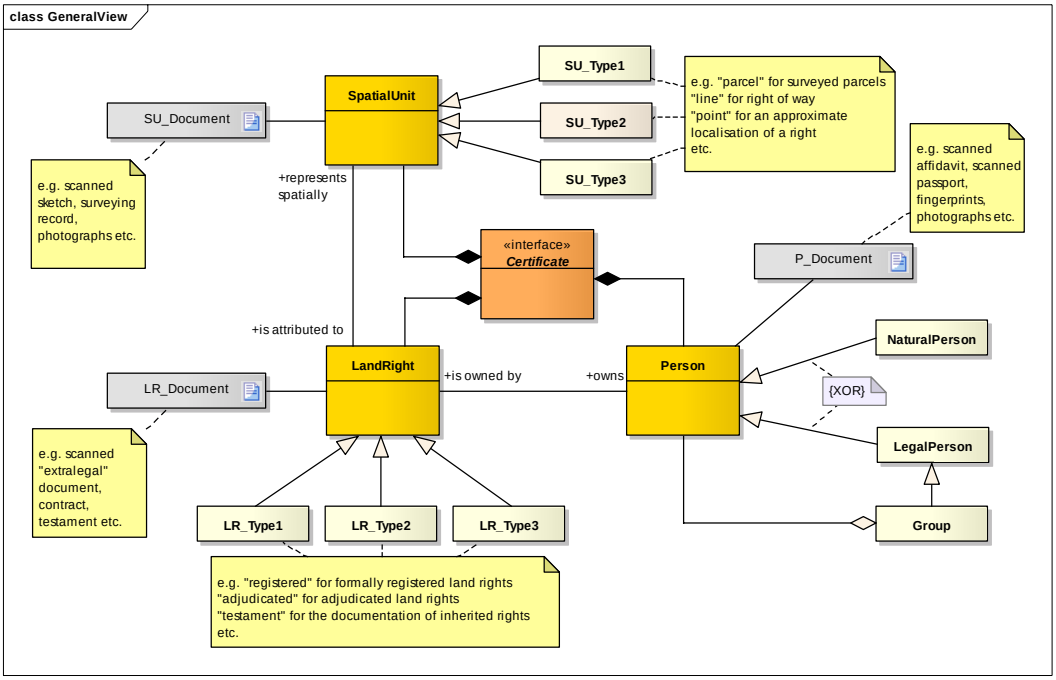
UC verify content: Newly registered land rights need to be verified and confirmed (e.g. by a village council, a super ordinate administrative unit, a court, existing

cadastral data etc.). Therefore the ULR application offers the possibility to print out a provisional document containing all the necessary information. Once the land right information is verified (and – if necessary – corrected) its state in the ULR is updated and the final document for all involved parties is printed and handed out.

3.3 Data Model

The proposed data model follows the FIG recommendations for the Social Tenure Domain Model (STDM, cf. Lemmen et al. 2007). It is discussed in depth by Mithöfer (2008). The ULR data model describes relationships between persons (“Person”) and land (“SpatialUnit”) through a land tenure relation (Figure 3). Land tenure comprises all rights, restrictions and responsibilities (RRR).

Figure 3: Overview of the data model for the Universal Land Registry (ULR).



The ULR supports the registration of persons, including natural and legal persons (e.g. an institution, corporation or company or other entities representing social structures). A “Group” is described as a group of persons. Usually, a person would be registered to the system with the Tanzanian ID or passport number and their particulars. Since many Tanzanians do not possess a passport or ID, the system supports the registration of personal identification measures as

photographs, fingerprints and scanned documents as affidavit of identity. Applicants without national identification papers require a written document conducted by any legal person or village administration to verify the personal identity. All registered persons, organisations or groups will be held in a national database to prevent registration of redundant personal information and ease the registration for persons who claim land rights in different villages, wards or districts.

The core function of the “LandRight” class is to capture land right documents and link them to “Person” and “SpatialUnit”. A land right document can be linked to one or more spatial entities as well as to several persons. This allows for example the modelling of co-ownership of land. It is also possible to link a spatial unit to different land documents like for ownership, collateral and sub-lease. Tenure documents can either be legal certificates, existing cadastral data (digital or analogue) or customary land rights either written or in oral tradition, which will be transferred through a community administrative body to a written document. The type of tenure relationship is captured in the database as a tenure type (see Figure 3 “LR_type 1” etc.), which is further aggregated to tenure classes to ensure regional and nationwide standards and enable a layer based view on certain tenure systems (e.g. parcel based ownership, customary ownership, overlapping land rights, disputed land).

The “SpatialUnit” can be realized as a point, a line or a polygon (topologically clean or overlapping) depending on the land right characteristic (e.g. access right as linear element) and the technique of georeferencing applied (on-screen digitizing, GPS points, import of cadastral data). All data are stored in a spatially enabled relational database following the OGC Simple Features Specification for SQL (Structured Query Language) (OGC 2006a, 2006b). This standard is for example implemented in PostGIS (cf. Postgis), an open-source extension for the PostgreSQL object-relational database management system (cf. Postgresql) as well as in several commercial database management systems (DBMS).

The “SpatialUnit” contains the geographic data, the scanned survey document and a textual description of the boundary. It is also possible to attach sketch maps and photographs to explain in detail the exact location in case of point registration or block registration. A block registration an appropriate method to register e.g. a definite number of small scale farms in rural areas or tenancy in informal settlements inside a specific area. This systematic block registration was successfully implemented in Namibia to formalize land ownership in informal settlements (Christensen 2004).

The data capture process incorporates a detailed documentation through system metadata containing the data source, the surveying method applied and the co-ordinate accuracy. The adequate use of metadata is the foremost step to

implement measures to ensure the correct use of data and the development of data analysis approaches to support of the spatial analysis of land disputes and overlapping land rights

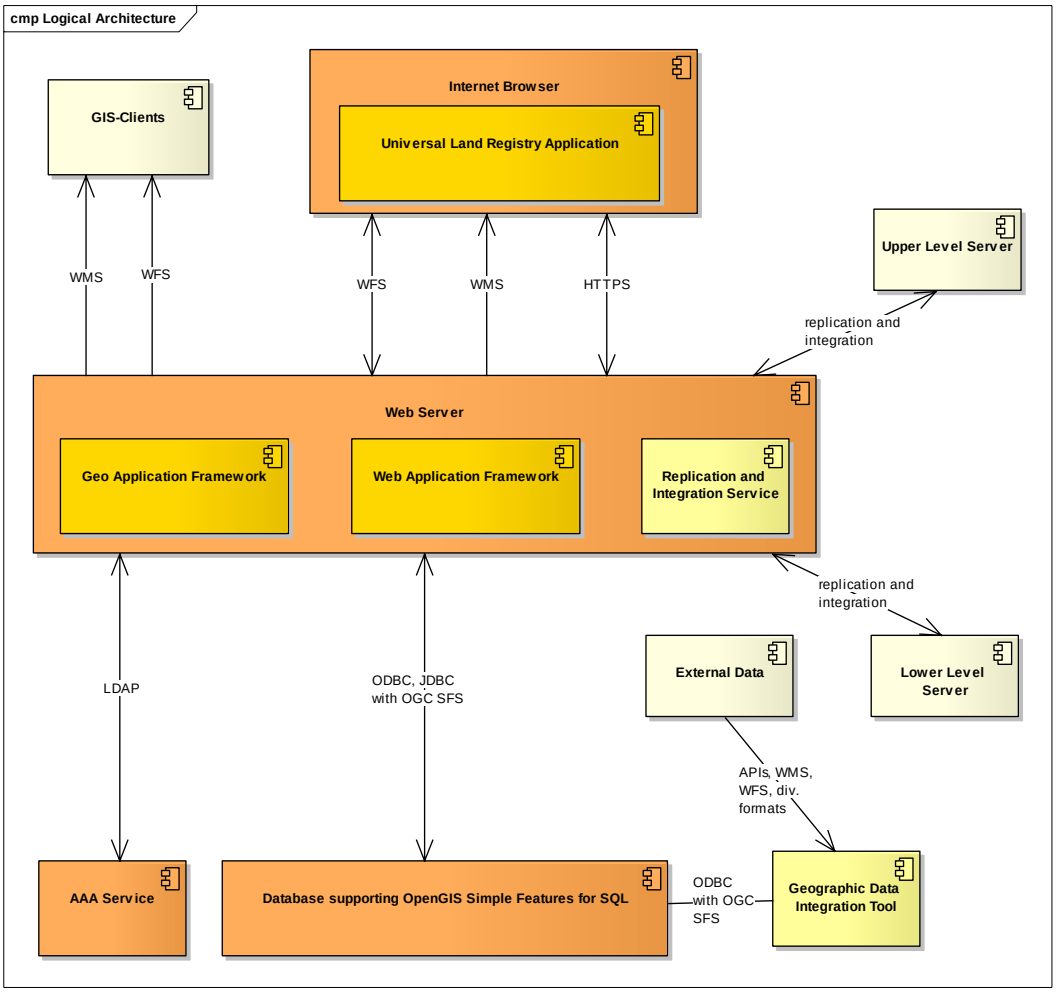
The existing documentation of land rights varies quite a lot in Tanzania (120 tribes, about 11,000 villages, rural areas and high density informal settlements etc.). A basic set of tenure types can be derived from the analysis documents (de Soto 2006), which describe archetypes of property registration and transaction. If need arises, further archetypes can be introduced into the registration process by local users, however the formalisation process should be geared towards simplification. It will be the responsibility of a national administrative body to coordinate the implementation and standardisation of tenure classes to ensure a maximum flexibility and practicability of the system. This classification of land rights is a key component to ensure GIS functionality as search and overlay of different land right classes (national standards vs. local variability) in line with the FIG cadastre 2014 proposal.

The “Certificate”, finally, is an aggregation of “Person”, “LandTenure” and “SpatialUnit” to support the generation of required artefacts such as printing of documents. Paper documentation in the hand of land owners and in local land registration offices is an additional measure to ensure proper procedures and trust related to land transactions. If there is a mismatch between the printed documents and the records in the ULR, someone possibly has been tampering with the system. This fact can be traced using the logs and metadata of the system. Furthermore, people who do not understand anything about computer systems and how they assure security and tracebility can still build their confidence on the paper print-out of their individual transaction within the system. Trust in the system by all parties involved is crucial for its success.

3.4 Components and Architecture

Figure 4 is a UML component diagram of the logical architecture of the universal land registry. This view is independent of the technology used to implement the system. In a prototype implementation the main parts of this architecture were implemented mainly with open source components, but the same could be achieved with corresponding commercial components. The system is subdivided in several layers in the design of a multi-tiers architecture. The end-user application for the land registration officers runs in a Web browser and is functionally tuned for an effective execution of the data capturing and browsing use cases. All the end-user screens are designed in graphical screen layouts. With these screen layouts the application can be optimized for usability in discussion with end-users before implementing them (cf. Figure 5).

Figure 4: Logical components of the Universal Land Registry (ULR).

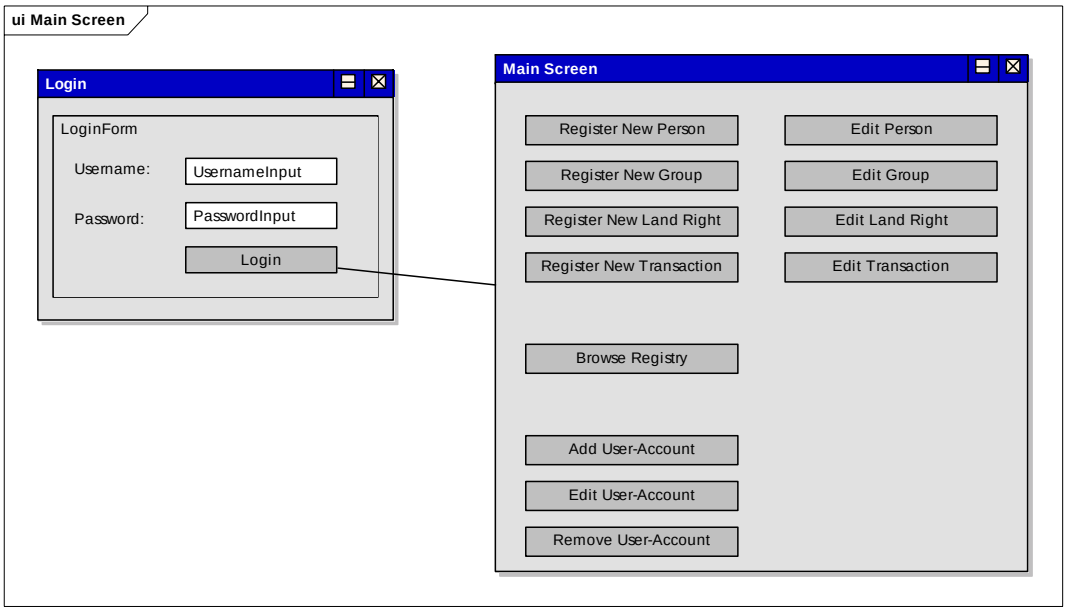


Transactions and data provisioning functions are modularized to form – whenever possible – independent atomic services on the Web and application service layer. This increases the robustness of the overall application while reducing its complexity. Furthermore, with a service oriented approach, control over the different transactions is much simpler to gain than in classic desktop or client/server applications. This is particularly important to trace back cases of misuse particularly by authorized persons.

The data repository is divided in two systems, one for the user authentication, authorization and accounting, the other for the storage of the land rights records with georeferencing and all attached documents. This separation is best practice

for keeping core application independent of the organisation managing the related business cases and transactions. Furthermore, it creates an additional level of security and traceability for the whole system.

Figure 5: Example of a screen layout.



The universal land registry is designed for distributed online and offline operation from the beginning. Distribution is supported by data replication and integration services. Relatively static background data like code lists and geographic base data can be inserted anywhere in the system and will automatically be propagated to the other nodes whenever they have a network connection. Replication of triple-A information is based on the well-established LDAP protocol.

The most difficult part is the distribution and integration of land right and person records, whereby responsibilities and control mechanisms at different levels of hierarchy must be considered, as well as data integrity constraints. A configurable replication and data integration service on each node has to cater for this. By principle, no transaction in the land registry should be carried out by a single person. A control mechanism is considered, whereby each transaction at whatever level of administration needs to be approved by another level of administration, lower or higher, depending on the nature of the transaction. Organizational details of this procedure are going to be elaborated in the forthcoming requirements analysis for implementation.

4 IMPLEMENTATION STRATEGY

The "Strategic Plan for the Implementation of the Land Laws" (MLHSD 2005) outlines the re-organisation of the land registration in Tanzania and the implementation of GIS technology. Furthermore, pilot studies conducted in Handeni District and Dar es Salaam outline the procedures to register customary land rights and to produce land certificates (MLHSD 2006, LHRC 2007, TAPHGO 2007). A flexible universal land registry (ULR) would now be right in place to support the Tanzanian Property and Business Formalisation Programme Mkurabita.

From past experience it is obvious that land right registration not preceded by land use planning does not make sense. It would call for conflicts to register whatever land is claimed to be in private use only to expropriate the owners afterwards because they settled in an unsuitable are in the first place. Therefore the land registration solution should be preceded by an effort to integrate all existing geographic data on administrative boundaries, topography, existing land use plans and the conditions of the environment. In a prototype implementation, publically available aerial and satellite imagery was integrated by using open as well as proprietary web mapping interfaces.

Data structures and tools to consolidate this baseline information to consistent land use plans have then to be provided. This would be a first step to build a solid Tanzanian spatial data infrastructure (SDI) on which the ULR could be constructed step by step from a pilot registry to a fully distributed system supporting the newly introduced registration procedures throughout the country.

The ULR implementation strategy is based on existing project experience in Tanzania in land right formalization. The pilot studies conducted revealed that the ULR application needs to be integrated into the formalization process in rural and urban areas which includes the following steps:

- Delineate the administrative boundary for land registration (village boundary or block).
- Participatory mapping of topography, infrastructures and environmental conditions to produce topographic baseline data (Village Land Use Plan).
- Process application forms between applicants, local and district administration.
- Compile land right information (survey, adjudication process) and identify land objects and persons.

The land right formalisation process is conducted in a first stage in campaigns comprising adjacent villages in a district. All claims are registered in a local spatial database using a field computer with adequate screen size (laptop). The computer is equipped with ULR in offline operation including a local database as well as all devices for data capturing (e.g. GPS receiver, scanner). The process of registration is usually conducted by the Village Land Officer and locally trained staff in a participatory process. The ULR application encompasses besides the registration of persons, documents and land objects the use and update of topographic data required for the land right registration.

The printout of land right documents supports the establishment of the village cadastre required by law. The field computer will be available at agreed times in the village to update data, conduct transactions or to print land certificates. The village registry stores the paper based cadastre produced by the ULR (printouts of documents and maps) to provide information for periods when the technical equipment is not available at the village

In addition to the establishment of the land use planning infrastructure and the field test of the proposed ULR system, further conceptual and organizational questions need to be clarified, preferably in a collaborative effort with the local partners responsible in the respective area:

- Customary practices: research extralegal archetypes in more detail and define national standards to integrate customary practices and documentation into the legal framework as outlined in the ILD studies.
- Geographic names: develop a database containing geographic names and their standardised spelling for use by all land rights registration units nation-wide. Here and in the next point, openly available geographic data services should be integrated wherever the reliability and quality of the source as well as network reliability allow.
- Topographic mapping: develop standards in topographic mapping for the establishment of Village Land Use Plans.
- Support for illiterate users: develop standardised measures (e.g. graphical visualisation of land rights) and procedures to ensure that illiterate land owners are able to secure their land rights (Mithöfer 2008).

4.1 Organization of the Operational System

The idea of first drafting a solution design is based on the rule of thumb that one hour spent in analysis and design saves five hours of coding and fifty hours in debugging. The IT solution can only be built cost effectively and to the purpose if the requirements are known early enough and a proper solution design is prepared. One crucial requirement of the ULR is that the system is highly

distributed, but data need to be consistently integrated at different levels. Special attention has to be paid in the deployment concept for the operational system and the functionality for replication, data integration and interoperability.

Figure 6: Schematic view of the deployment of the Universal Land Registry (ULR) with data replication flows.

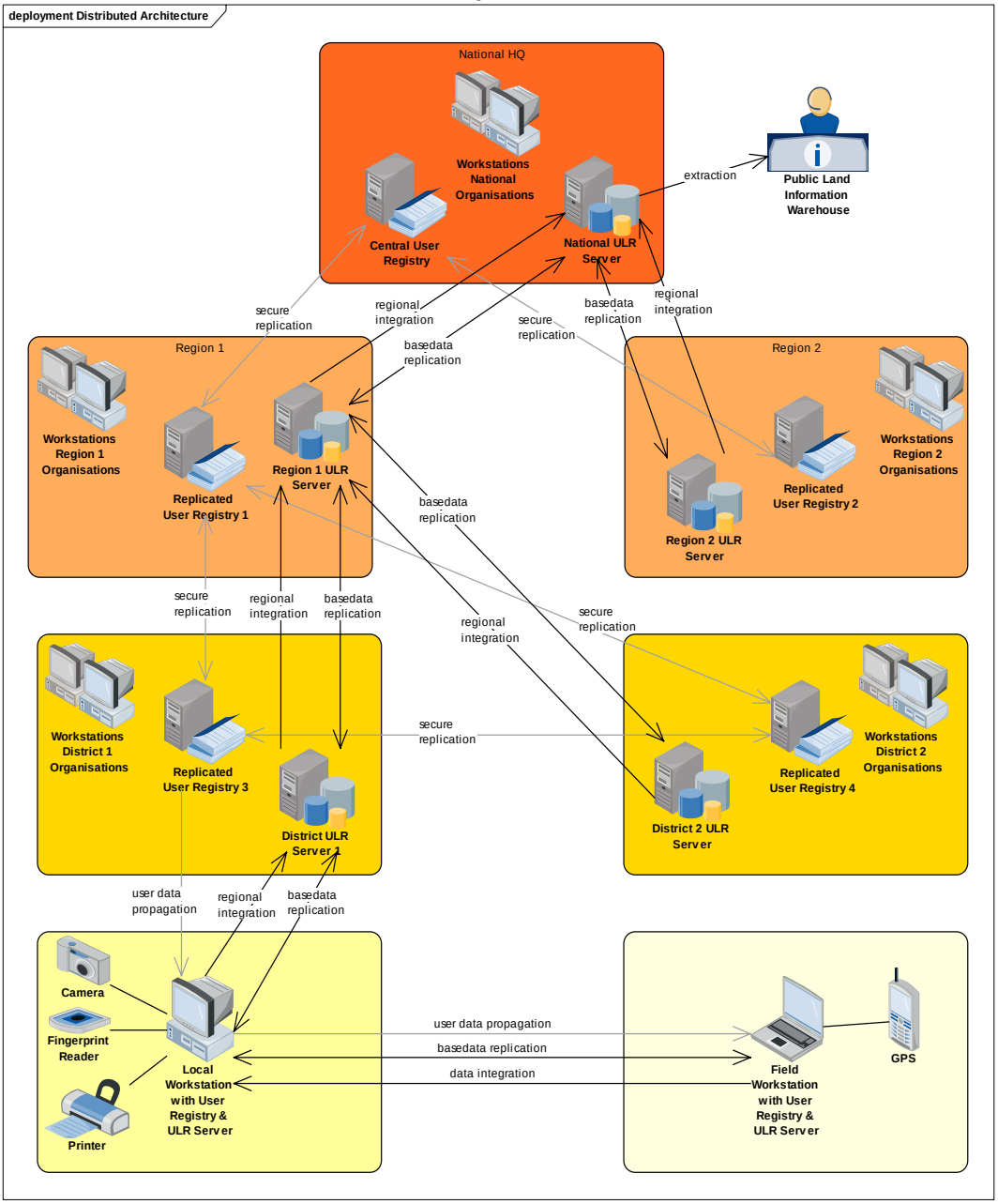


Figure 6 shows a first draft for the deployment concept. It is proposed to define a master node for each geographical unit. This could be an offline workstation in a village or a server at district level. For field work, also a field computer could temporarily play the role of a master. Only the master (server) can accept transactions within its territory. When a master node is connected to the network and reaches the next higher node in the regional hierarchy, all new transactions within its territory are propagated upwards. However, not all transactions are carried out at the bottom level and propagated upwards. Regional planning, transhumance, environmental and natural protection, amongst others, need the possibility to impose land use restrictions and land occupancy rights at higher levels in the spatial hierarchy, which could not be overturned at the village level. But in reverse, the system also has to be protected from misuse by persons with transaction rights at high geographic levels who could use their power to overturn local decisions for personal interests or the interests of their family and friends. A solution could be to validate high level transactions only after approval by all local level “masters”.

With this concept, the same replication and data integration procedure can be used at all geographic levels up to the national Government. At the lowest level, a field computer, when brought back to the office, will hand over its transactions to the local server and stop being master. At the top, a region server collects all transactions from the districts and propagates them to the top node at national level. Again, besides fulfilling the practical requirements imposed by the nature of the task, this replication and integration design helps stabilize the overall system with redundancies and control mechanisms, an aspect that cannot be stressed enough under the given circumstances. By clearly identifying a master source system for a transaction, a mediation procedure in cases of inconsistency will help avoid the well-known negative effects of redundancy.

The deployment model also emphasises the importance of data exchange between the different administrative levels for data dissemination and the verification process. These processes can be negatively affected by the weak communication and/or electrification infrastructure in the rural areas. This especially affects the data exchange between a local registry and the District Land Office. Data replication might not be possible at any time, which may lead to delays especially in the initial phase of the formalization process during which land rights are registered en masse in campaigns. The implementation therefore requires careful planning with well defined schedules and deadlines for replication to ensure a transparent and reliable process. Unconventional methods like the use of messengers carrying data storage devices might be an option to deal with weaknesses in infrastructure (Mithöfer 2008).

4.2 Core Data for a National Spatial Data Infrastructure

The construction of the universal land registry will take a long time, in fact the same amount of time the formalisation programme takes. From the experience in other countries with better starting conditions a minimal time frame of 15 to 20 years is realistic. It is good to know that by the time of completion, an excellent land information system would be ready for use. However, a lot of other important projects and programmes in Tanzania need geographic data for planning, operation and documentation and they cannot wait. From the beginning, the ULR will need the same geographic base data as these other projects. It is not the role of the ULR or of its related land use planning project to build the National Spatial Data Infrastructure. It is therefore suggested as a “quick win”, to coordinate the base data preparation for land registration with all other GIS activities within the Government of Tanzania. The technology and the interfaces proposed for the ULR follow international OpenGIS® and ISO standards. With a minimal extra effort, the base data of the ULR can be made available interoperably for other GIS applications without any negative impact on the security or performance of the ULR. Not using the investments in a large spatial data collection programme for the construction of a National Spatial Data Infrastructure would be a missed chance.

5 CONCLUSIONS AND OUTLOOK

The potential for individual development of citizens largely depend on how a government organises vital services like security, infrastructure, health care and environmental protection. While governmental administrations in developed countries largely use information technology to optimize the provisioning of services, governments of Third World countries not only lack the financial resources for computerization but also the know-how to define their needs in order to be able to actively seek for solutions. Transfer of experience and know-how in the construction of governmental IT applications will probably have more positive effects on the development of a Third World country per dollar spent than expensive physical infrastructure projects. This because today, relatively cheap, yet well conceived IT solutions are available to help the governmental administration create better frame conditions for the individual development of each inhabitant while at the same time optimizing resource utilization at large. In fact, how can aid agencies of developed countries assume that infrastructure projects, which are handled with the help of large IT systems in developed countries, could effectively be put in place in developing countries without IT support?

The universal land registry solution design is a humble private contribution from GIS and IT experts to this important know-how transfer, not least motivated through the conducive political environment of Tanzania. They know their

business and know that a properly designed geographic database application will help Mkurabita. However, with the completion of the ULR solution design, the limit of the possibilities of volunteer work is reached. A solution design is an important step in the optimization of governmental procedures, but next steps have to be financed like ordinary IT projects. The good news is that technical solutions have become affordable. The GIS tools currently used by the Tanzanian Government are still expensive and complicated tools in the hands of a few experts. The open ULR solution is designed for the few operations needed in the process of land registration, simple, robust and reliable, for the hands of many.

The solution design presented in this paper has been developed by the authors since September 2006 with own funds. To avoid unnecessary distraction for the volunteering solution architects, only very few contacts to key persons in Mkurabita and in the Tanzanian Government took place. It was agreed that the ULR solution design would be presented once it is mature enough for a pilot study in the field, which is now the case after the termination of the master theses by K. Mithöfer and P. Schär. All decision makers and influencers, who were informed about the ULR so far, unanimously agree on its value and importance for the land tenure formalisation programme. The next step must therefore be a pilot study that builds on the experiences from the ULR prototype and the Handeni and Dar es Salaam field studies. Optimally the pilot would cover an urban and a rural area. Urban areas are still badly surveyed and only small fractions of the properties are formally registered. The ULR should be tested in such areas where formalisation of property has a major impact on taxation and private wealth accumulation. On the other hand, rural areas make the largest proportion of the country and their development is a challenge in terms of infrastructure management, environment and social stability. If the ULR can be shaped under such diverse conditions, it can grow to the expectation of a “universal” system. Currently, financing of the pilot study is sought for.

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