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TENURE AND GLOBAL CLIMATE CHANGE

A REVIEW OF MOBILE TOOLS AND APPLICATIONS FOR COLLECTING LAND INFORMATION AT THE COMMUNITY LEVEL

JANUARY 2016
This publication was produced for review by the United States Agency for International Development. It was prepared by Tetra Tech.

This publication was produced for review by the United States Agency for International Development by Tetra Tech, through Strengthening Tenure and Resource Rights IQC Tenure and Global Climate Change AID-OAA-TO-13-00016.

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DISCLAIMER

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EXECUTIVE SUMMARY

This study discusses current technology options that facilitate the collection and recording of customary land information as anticipated for use across three pilot sites in rural Burma. This document should be reviewed in conjunction with TGCC Burma participatory mapping process resources.

A rapidly changing technology landscape has seen the development of a plethora of technology solutions, often based on mobile technologies, which provide the technological means to rapidly collect and record information related to customary tenure.

In Burma, the Tenure and Global Climate Change (TGCC) project is seeking to identify and test models that strengthen resource tenure governance and property rights, while improving the sustainable management of landscapes. As part of TGCC Burma's support of the developing draft National Land Use Policy, the project will be testing approaches to document and recognize customary rights to forests, agricultural land and other types of land at the village tract level.

In lieu of an operational legislative framework, mapping activities will consider articles of the draft National Land Use Policy and mirror international land data standards such as the Social Tenure Domain Model (STDM). Mobile tools tested at TGCC Burma pilot sites should also have the potential to scale and integrate with other ongoing efforts, such as the Swiss Agency for Development and Cooperation's OneMap project. OneMap is supporting the development of an open access spatial database for land related information. OneMap spatial data standards have not been developed and so TGCC map outputs will be compliant with available STDM standards.

Testing different approaches involves introducing new map tools into a series of well documented participatory mapping approaches. New technologies that provide simple yet effective means for rapidly collecting land use inventory and customary tenure information in a cost effective and sustainable manner will be evaluated.

This paper evaluates suitable technology options that will modernize, streamline and simplify documentation of land resources in TGCC Burma's three rural pilot sites at the village tract level. The pilot will test traditional mapping methods in comparison with new mobile solutions by mapping village boundaries and land use/land cover within each village. Mapping activities will not involve individual claims and certification, but will involve documentation of perceived rights to be held and used locally.

Introducing suitable, fit-for-purpose technologies seeks to save significant time and resources. In addition, these technologies will provide means to make the process more transparent, accountable and cost effective by empowering local communities and civil society organizations to take part.

This study is divided into two sections: 1, an overview of available technology options and considerations for selecting appropriate technologies, and 2, recommendations and next steps based upon the local conditions found in the Burma.

1.0 OVERVIEW OF TECHNOLOGY OPTIONS

1.1 MOBILE MAPPING TOOL CRITERIA

To determine potential tools for use in the TGCC Burma context, we evaluated technology solutions based on the criteria described in Box A with the intention of ensuring that any technologies piloted by TGCC Burma would be sustainable for use beyond the life of the project. To ensure sustainability, the technology solution must balance cost with usability, provide offline data capture functionality and have potential to be scaled and replicated. Usability and a low capacity building curve are key as data collectors are not trained surveyors and GIS Specialists, but community members and representatives of local civil society organizations.

BOX A. SUSTAINABLE LOCALIZED MOBILE TOOLS FOR LAND INFORMATION

- Low to no cost
- Allow for offline data capture
- Low capacity building curve for data collectors
- Ease of set up and maintenance
- Ability to integrate other spatial datasets
- Ease of transfer from data collection to management
- Potential to scale and replicate
- Language localization available

1.2 CONSIDERATION OF TECHNOLOGY OPTIONS

Using the tool criteria specified above, we evaluated several technology options, including tools intended primarily for the land tenure sector well as mobile mapping tools and platforms for broader business applications not specific to land information. Our evaluation included options that span the range between free and open source to costed, proprietary technologies. Keeping cost in mind, our research on proprietary options largely focused on low cost solutions.

To provide a full range of options, our research included leading proprietary solution providers such as Trimble and Esri. However, for the village boundary and land use unit mapping needs identified by TGCC Burma, these proprietary solutions are highly focused on cadastral registry of parcels at sub-meter accuracy for large, enterprise purposes. These objectives, as well as the high cost of proprietary software packages, eliminated these options from consideration.

Figure 3 depicts a matrix of technology solutions measured against selection criteria and Annex A describes top qualifying solutions in detail. This is a rapidly changing space and research reflects current availability so potential strong options, such as Cadasta, are not yet readily available. Of the top contenders our research found GeoODK and its associated components as the strongest free and open source option. Geospago and ANDMAP show strong promise as a low cost, proprietary option. Our research uncovered many similarities between different technology solutions as well as some important distinctions, which should be taken into consideration to inform planning and next steps.

Figure 1: Land Information Tool Options

	Application	Android	iOS	Open Source	Free	Non-spatial Data Capture	Cloud data storage & management	Offline Capability	Collect Features	Draw Features	Customizable	Wireless upload	Multi-media	Notes
LTPR Tools	MAST	●		●	●	●	●	●	●	●	●	●	●	Data model configured on STDM and LADM. Good for parcel-level land tenure data collection.
LTPR Tools	STDM			●	●									Not mobile - entirely desktop
LTPR Tools	Open Tenure	●	●	●	●	●	●	●	●	●		●	●	Data model configured on LADM. Good for recording claims for formal registration.
LTPR Tools	Cadasta			●	●	●	●	●						TBD early-2016
Generic Tools	Qfield (QGIS mobile)	●		●	●		●	●				●	●	In Beta testing phase. Good open source competitor to Esri.
Generic Tools	Geo Open Data Kit (ODK)	●		●	●	●	●	●	●	●	●	●	●	Large suite of tools that can be flexible and customizable for any data need.
Generic Tools	Collector for ArcGIS	●	●			●		●	●			●	●	Tool within Esri platform, easily integrated with ArcGIS Online. $2,500 /year for 5 users
Generic Tools	Geospago	●	●			●	●	●	●	●	●	●	●	One simple platform for data collection, management, and visualization. $14.99 /mo or $164.89 /yr per user
Generic Tools	ANDMAP	●				●	●	●	●	●	●	●	●	Well designed for utilities, less options for form customization. $199 per device per year
Generic Tools	Fulcrum	●	●			●		●	●		●	●	●	No line and polygon collection. $18 /mo per user

All of the top contenders for use by TGCC Burma have several important similarities in the functionalities of the mobile application.

- All applications allow for spatial and non-spatial (attribute) data capture in an offline environment where collected data can be stored on a device until connected to a wi-fi or cellular network. This allows data collectors to perform work even when the data collection site has limited or no connectivity.
- Each option allows for the capture of points, lines and polygons as spatial features, which allows for varied data collection depending on needs identified by the project. For example, data collectors may start with a point layer to identify main geographic features and then draw polygons to identify community boundaries.
- Non-spatial data fields (attributes) can be customized according to the local needs and include capture of media files such as picture, audio and video. Non-spatial data will provide important details, such as information about an individual submitting a claim for customary land rights.
- To facilitate spatial data capture, data can be collected over customized basemap imagery that is loaded onto the tablet in tiles and can be used when disconnected from the internet.
- To serve as reference, other spatial datasets can be integrated onto the display of the mobile device.
- All applications are available on the Android operating system, though Mobile Applications to Secure Tenure (MAST) is not yet available on the Google Play store as it is still in pilot phase.

Similarities in the mobile application also extend to data management as all applications can be linked to a locally hosted or cloud-based server.

Despite multiple similarities in applications there are several important distinctions and differences to consider. These considerations can be divided into two main two main questions:

1) What types of data will be captured and managed by TGCC Burma?
2) What technology solution is most feasible for sustainability and ease-of-use by local stakeholders?

Data to be captured and managed. All technology options considered for this study utilize electronic forms with customizable data fields that replicate questions that would be present in a paper form. Electronic forms improve efficiency of data collection and management by creating standard questions and fields that eliminates many data collection errors and provides and easy-to-use interface for data collection.

Several of the technologies under consideration are land tenure specific applications that already have elements of the STDM data schema. These applications—MAST, Open Tenure and the upcoming Cadasta—have pre-configured data fields and relationships established between person-social tenure relationship-spatial unit. While these non-spatial data fields (attributes) can be customized and configured, the main focus of these applications is on the collection of individual parcel data.

In contrast, technology options that are not land tenure specific do not have the defined person-social tenure relationship-spatial unit relationship established as a data schema, but do allow for fully customizable data fields. These tools would allow for all or part of the STDM data model to be constructed as mobile forms. Depending on the complexity of data collection needs, data could be collected in a simple environment and integrated with a more complex database after collection.

For the purposes of the TGCC Burma use case, hand drawn geographic features will provide sufficient accuracy provided that features are digitized at a large scale. Survey-level accuracy is not required according to the current participatory mapping process.

Comprehensive or multi-component solution. Our research determined that, while many technology options may have similar functionalities for data collectors, there are quite a few differences in how easy each solution is to set up and maintain. For example, to set up and configure a **GeoODK** instance, a manager would need to design and build forms in Excel using a separate **XLSForm** tool, set up and configure a server on **Formhub** or **ODK Aggregate**, and build web integrations to separate webmapping platforms in order to edit and manipulate spatial data loaded to the server (or download data to a GIS for editing and analysis).

By contrast, a similar workflow using an application such as **Geospago** would be housed within one inclusive platform. Forms are designed and constructed online using a simple graphical user interface (GUI), which consists of graphic icons and visual guides to direct the user. Forms and associated data are managed on a fully integrated server and spatial data can be reviewed, validated and edited on the same server interface. Permissions can be administered to users in order to ensure that data editing is only carried out by appropriate staff.

There are important trade-offs between ease of set up and management and cost implications. **GeoODK** and its associated components such as **XLSForm** has a heavier set up and management burden, but is free and open source and cost would only involve web hosting. **Geospago** provides an easy to navigate interface and integrated form design, collection and management functionalities, but also comes with a cost per user of $15 per month. It is also important to note that the sustainability of free and open source software relies on having broad based buy-in and continuous development by the open source community to keep up with constantly evolving technologies, otherwise it runs the risk of becoming outdated. For example, **Formhub**, which could serve as a component of a **GeoODK** solution is no longer being maintained. Conversely, it may not be feasible for civil society organizations to bear monthly costs for data collection.

Needs will differ for each use case and while free and open source technology options will require a higher capacity building curve for set up and maintenance, the lack of associated costs may make an open source solution the best choice. If an organization has strong IT support and limited budget, an open source solution would be ideal. Similarly, if cost is not of primary concern and ease of set up and maintenance is the primary goal, a low cost proprietary option may be the best choice. Low cost proprietary option provides users access to support and help desk functionality and software updates would be maintained by the platform developer.

2.0 RECOMMENDATIONS FOR TGCC BURMA PILOT SITES

For TGCC Burma's pilot sites we recognize the need to demonstrate efficiency and effectiveness by testing fit-for-purpose technologies that allow communities and stakeholders to rapidly collect information on village boundaries and village land use units. Technology solutions will be tested as part of the participatory mapping process and will be utilized at community meetings for village boundary demarcation as well as for land use unit identification.

In lieu of an operational legislative framework to which mapping activities can be tied, data will be collected with the draft policy and international standards in mind and with the intention of integrating with other national efforts, such as OneMap, which is still in the process of defining data collection standards. With the development of OneMap in progress, which will serve as a central database for land information, the primary goal of the TGCC pilot sites should focus on sustainable methods for data collection at the community level with the intention that data collected at the community level will eventually be integrated into OneMap.

TGCC Burma project staff will assist with the identification of attribute fields, an activity that will occur in collaboration with civil society organizations including the Land Core Group, at an upcoming participatory mapping workshop hosted by the project in Yangon, to be collected during both mapping phases. These fields will be informed by the draft National Land Use Policy and STDM. According to the draft National Land Use Policy, land use can be divided into different zones (see Box B), which may be further defined by local district land use committees. STDM provides a data schema to record establish a social tenure relationship between spatial units and parties. Details of these data tables are described in Annex B and will be adapted with the input of local stakeholders. TGCC Burma pilot activities will utilize limited, standardized attribute fields for community boundary demarcation. Attribute fields to be collected for land use units will be defined with local stakeholders. All mobile mapping technology solutions presented in this study allow for the customization of forms depending upon specific needs.

BOX B. LAND USE ZONES ACCORDING TO DRAFT NATIONAL LAND USE POLICY

- Urban and rural development zone
- Agriculture zone
- Livestock breeding and fishery zone
- Protected area zone or national security zone
- Commercial zone, industrial zone or mining zone
- Grazing land zone
- Forest zone

To commence with piloting activities, the following next steps are recommended:

- Identify opportunities in the TGCC Burma participatory mapping process where mobile mapping tools can be integrated into existing processes, namely at community meetings for village boundary mapping as well as for land use unit identification processes. Use of mobile tools at community meetings should be coupled with a mobile projector so all community members can provide feedback as landmarks and boundaries are mapped.

- Determine technology solutions to be tested in the field and develop criteria by which effectiveness and efficiency can be measured to compare tools.

- Work with local stakeholders and TGCC Burma project staff to define spatial and non-spatial data fields to be collected for both village boundary demarcation and land use unit identification.

- Prepare technologies for testing by providing a training of trainers to local stakeholders.

- Test mobile mapping technologies and measure for effectiveness and efficiencies while also noting lessons learned.

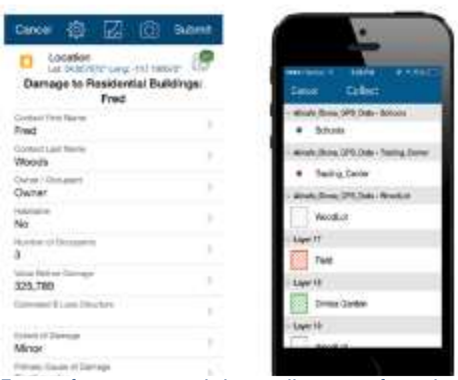
For the purposes of technology solution testing, we recommend testing a free and open source option such as **GeoODK** and its associated components alongside a low cost, proprietary option such as **Geospago** or **ANDMAP**. These technology options are a strong fit for the TGCC Burma use case and highlight different approaches to mobile mapping that can be readily compared and tested.

3.0 ANNEX A: TECHNOLOGY OPTIONS

ESRI Collector ArcGIS

Esri is an industry standard provider of enterprise-level geospatial software and applications. Collector for ArcGIS is the mobile application for data collection which works with ArcGIS Online and Desktop for data management and visualization. You must have a subcription for ArcGIS Online (or Desktop license which provides access to ArcGIS Online) in order to work with Collector.

Advantages: Esri products come with extensive support services, training resources, and tools. ArcGIS provides a complete GIS Platform. Users have the benefit of collecting, managing, editing, analyzing, and visualizing data using just a few tools offered within the same platform.



Forms for non-spatial data collection of residential buildings (left) and spatial data collection of social and natural resources (right).

Components and Capabilities:

Data Collection – Collector for ArcGIS

- Available on Android, iOS, or Window devices
- Captures spatial and non-spatial data
- Offline data capture
- Capability to load custom basemap and satellite imagery, available offline
- Customizable forms or editable industry templates for download

Data Management – ArcGIS Online

- Data editing and analysis
- Data validation
- Customizable fields

Data Visualization – ArcGIS Online

- Edit, analyze, visualize, and share data
- Web map creation and sharing

Operating System:

Android, iOS, Windows; available via Google Play, Apple Store, or Windows Store.

Cost:

Mobile application is free. ArcGIS Online subscription is $2,500/year per 5 users.

Language Adaptation:

Currently available in 27 languages.

Capacity Building Curve:

Data Collection: Medium – Simple interface, requires training for preparing maps on ArcGIS Online for Collector

Platform Management: Medium – Manager must be able to administer ArcGIS Online

Use Case:

Esri Collector for ArcGIS was used by a local NGO in Malawi's capital, Lilongwe, to understand how agricultural field arrangements impact the adoption of climate smart agriculture techniques by smallholder farmers. Enumerators collected spatial and non-spatial data from 1,500 households using the Collector app. Data gathered was then wirelessly uploaded to ArcGIS Online for visualization and analysis. The NGO was able to analyze how perceptions of well-being are related to proximity of natural and social resources.

Geospago

Geospago provides an all-purpose mobile data collection application where users collect, manage, visualize and edit data all in one simple platform. Geospago provides a project- or enterprise-level solution, which allows for scalability. Though it is not open source, the platform is available at an affordable price point relative to other proprietary solutions that require substantial investment.

Advantages: Geospago is a one-stop-shop for data collection, management, and visualization; there is no need for additional platforms. The monthly fee provides access to the support team, technical resources, and training videos. Geospago seeks to serve the development industry by developing its next iteration – due to launch early 2016 – with development issues in mind, such as low connectivity, low technical capacity, and complex security concerns. Data is highly encrypted and security can be scaled based on the country context.

Toilet and latrine data displayed on a basemap, basic data visible by scrolling over points.

Components and Capabilities:

Data Collection

- Android or iOS-based mobile application
- Captures spatial and non-spatial data
- Offline data capture
- Capability to load custom basemaps and MBtiles, available offline
- Customized forms and spatial features, editable from mobile device

Cloud-based Data Management

- Open API
- Searchable database
- Highly encrypted
- Data editing via web application

Data Visualization

- Interactive map built in to platform, no need for third party platform
- One-click sharing capability via link or social media. Can be password protected.

Operating System:

Android or iOS, available via Google Play or Apple Store.

Cost:

Mobile application is free. Platform is $14.99/mo or $164.89/yr per user

Language Adaptation:

Currently available in 3 languages, with ability to customize further.

Capacity Building Curve:

Data Collection: Low – interface is simple and easy to navigate

Platform management: Low – no server setup or maintenance required

Use Case:

Geospago provided data collection and mapping technologies for Wash Liberia, a major initiative by the Government of Liberia and Oxfam to increase safe water coverage and reduce diseases. Volunteers were trained in one day to use Geospago to collect over 2,500 data points in 12 weeks, utilizing pre-built forms and offline map tiles which was critical for the low-connectivity environment. Data was later synced to the cloud for management of an inventory of sanitation services and manholes.

Mobile Application to Secure Tenure (MAST)

MAST is a free and open-source mobile application developed to capture information regarding land tenure to be able to issue formal documentation of land rights. The application is currently being piloted by Cloudburst in Tanzania, funded by USAID. The pilot is being administered from 2014 until 2016. There is currently no information about the future of the pilot or the application beyond the initial contract duration.

Advantages: The MAST platform is designed specifically to address land tenure at the parcel level. The pilot program pairs the technological platform with participatory approach to training and education on the platform, the process, and Tanzanian land laws. The data model is configured base on LADM/STDM.

Satellite imagery used to capture spatial data, demarcating land parcels

Components and Capabilities:

Data Collection

- Android-based mobile application
- Captures spatial and non-spatial data related to land rights
- Offline data capture
- Capability to load basemap and satellite imagery, available offline

Data Management

- Cloud-based data management server
- Validation of data into a relational database configured on LADM/STDM
- Customizable fields
- Administration tool for customization and data security
- Configures and integrates template report and land rights documentation

Data Visualization

- Integration with external web-based GIS

Operating System:
Android, not publically available via Google Play. Source code is available on GitHub.

Cost:
Mobile application is free. Cloud server cost is $5-$15/mo.

Language Adaptation:
Currently only available in English

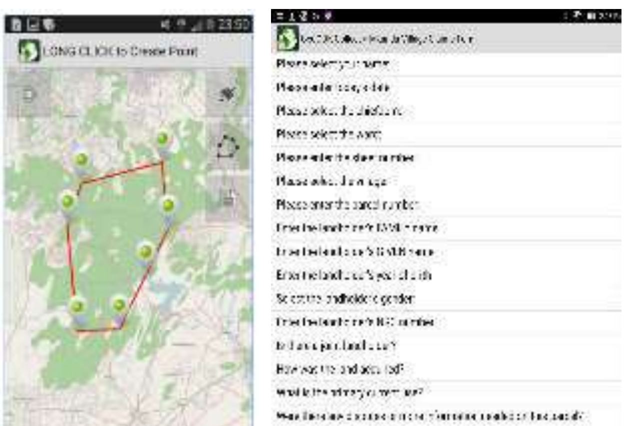
Capacity Building Curve:
Data Collection: High – absence of the application via Google Play results in complex installation and start-up
Platform Management: High – Manager must be able to set up PostGreSQL and PostGIS as well as a private or cloud-based server

Use Case:
Cloudburst has been contracted by USAID to design and implement a pilot called the Mobile Applications to Secure Tenure (MAST) project. Through the use of the mobile application, villagers identify parcel boundaries and gather demographic and tenure information. The data gathered is stored and managed in the cloud-based server and shared with the local government to issue formal title deeds for the land. The application is meant to provide a lower cost option for building a database of land rights claims, helping to improve land governance and decrease the cost of land certification programs.

Open Data Kit (ODK)

ODK is a suite of tools that can be used for all-purpose data collection, management, and visualization. All tools are free and open source, but require the purchase, setup, and management of a server in order to host and manage the platform and data collected. There are over ten different tools available, with other services being developed to meet the needs of the end users.

Advantages: ODK tools are based upon open data standards and provide a flexible solution for data needs. The ODK tools can be implemented independently or as a suite, and can be integrated with external applications through open source codes.



Map editing feature (left) and form used to collect data on village land tenure claims (right)

Components and Capabilities:

Data Collection – GeoODK Collect

- Android mobile application
- Captures non-spatial and spatial data
- Offline data capture
- Customizable fields
- Capability to load custom basemaps and MBtiles, available offline

Cloud-based Data Management - ODK Aggregate

- Bridges collection tool with analysis and visualization tools
- Sync and store data from multiple devices
- Export in common file formats
- Can run on Google infrastructure

Data Visualization

ODK Tables

- Edit and visualize data as list, spreadsheet, graph, or map. Sync with Aggregate.

Web mapping

- GeoODK can be integrated with a number of web mapping platforms

Operating System:

Android, available via Google Play.

Cost:

Mobile application is free. Cloud server is $5-$15/mo.

Language Adaptation:

Language adaptation through source code configuration.

Capacity Building Curve:

Data collection: Medium – capacity building required for creating forms in ODK build and collecting data with GeoODK Collect.

Platform Management: Medium – server setup and maintenance required.

Use Case:

GeoODK is currently being used by the USAID-funded Tenure and Global Climate Change (TGCC) Project to document customary land certification in Zambia. Community facilitators engage village members in participatory mapping exercises to map village boundaries. GeoODK forms developed using ODK Build collect demographic, spatial, and land and resource claims information. The Land Alliance Data Team manages and transfers data from ODK Aggregate into the Certification Database to create boundary maps. Certificates are distributed once claim data has been confirmed and any disputes have been resolved.

Solution for Open Land Tenure (SOLA) Open Tenure

Open Tenure is a free and open-source mobile application developed to provide an affordable, sustainable, and digitized cadaster and registration system for developing countries. The application was developed as an enabling technology for crowdsourced tenure rights information collection. There is currently no information about future funding for the application though Uganda may be adapting the platform.

Advantages: Open Tenure is being implemented with the FAO Voluntary Guidelines for Responsible Governance of Tenure (VGGT), promoting secure tenure rights and equitable access to land, a participatory process, and community self-governance. The data schema is compliant with LADM.

List of claims and claim details captured in Open Tenure form

Components and Capabilities:

Data Collection

- Android or iOS-based mobile application
- Captures spatial and non-spatial tenure rights information
- Offline data capture
- Capability to load basemap and satellite imagery, available offline

Data Management - SOLA Community Server

- Server can be cloud-based or local
- Relational database configured on LADM
- Community-moderated claims review
- Configures and integrates template report and land rights documentation

Data Visualization

- Integration with external web-based GIS

Operating System:

Android or iOS, available via Google Play or Apple Store. Source code avalable on Github.

Cost:

Mobile application is free. Cloud server cost is \$5-\$15/mo. Local server cost is about \$600 plus maintenance.

Language Adaptation:

Currently available in seven languages.

Capacity Building Curve:

Data Collection: Medium – simple interface, requires training in workflow roles and responsibilities

Platform Management: High – Manager must be able to set up and manage a cloud or local server

Use Case:

Open Tenure was implemented in Nigeria through FAO's engagement with the Nigeria Presidential Technical Committee on Land Record (PTCLR) and the GEMS3 project pilots for systematic land title registration (SLTR), funded by DFID. The goal of the project was to document land tenure and register formal land titles. There were challenges to customize the application for the six pilot states, particularly regarding the formatting of the land title certificates. The application was used to collect spatial information demarcating individual parcel boundaries in addition to non-spatial data regarding the parcel and land owner.

4.0 ANNEX B: THE SOCIAL TENURE DOMAIN MODEL

STDM is both a concept and a data model. As a concept, STDM is a pro-poor toolset intended to record ‘people–land’ relationships in countries with very little cadastral coverage such as urban slums or rural customary areas. As a data model, STDM is a specialization of the ISO-standard Land Administration Domain Model (LADM). ‘People–land’ relationships are “persons (or parties) having social tenure relationships to spatial units. The table below provides a description of each of these entities, which form the main modules (or tables) of the STDM data model.

Module	Description	Data Fields (illustrative)
Person/Party	A person, group of persons or non-natural persons that compose an identifiable single entity. A non-natural person may be a tribe, a family, a village, a company, a municipality, the state, a farmers’ cooperation, a church community, or a locally identifiable entity.	• Family Name • Other Name(s) • Address • Identification • Contact Telephone • Date of Birth • Gender • Marital Status
Spatial Unit	Areas of land (or water) where rights and social tenure relationships apply. Represented as a single point, set of unstructured lines, surface or 3D volume. Surveys may include identification of spatial units on a photograph, image or topographic map or locally drawn sketch maps.	• Code • Name • Type • Spatial Unit Use
Supporting Documents	Proof of evidence to the defined tenure	• Audio files • Video files • Rent certificate • Lease certificate • Title
Social Tenure Relationship	Relation of the person/party to spatial unit as supported by supporting documents. The right or “relationship” between parties and properties. May also include conflict information associated with a given property.	• Individual Owner • Part Owner/Shared Ownership • Lease • Occupant • Indigenous Rights • Possession • Other

Note: Data fields can be customized and additional fields can be added

Adapted from Lemmen, C., *The Social Tenure Domain Model: A Pro-Poor Land Tool*, Copenhagen: International Federation of Surveyors (FIG), 2010. Print.

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