THE NEED FOR STANDARDIZATION OF THE TECHNOLOGICAL APPROACHES FOR THE IMPLEMENTATION OF RURAL LAND SECURITY OPERATIONS IN WEST AFRICA

A COMPARATIVE STUDY OF THE CASE OF BENIN, BURKINA-FASO AND SENEGAL

Présentation
Daniel TOSSOU
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INTRODUCTION

- Land administration is a crucial issue that raises many thoughts.

Aware of the political, economic, socio-cultural and environmental stakes involved in the management of land, each country tries, as far as possible, to set up tools enabling it to better manage its land and secure the various rights related to it.

- With the advent of Geographic Information Systems (GIS), we are increasingly seeing the integration of their potential in the organization of land.

Thus, various geo-spatial databases are set up at the level of land administrations in order to allow efficient and transparent management of registered land rights.

Although the use of new technologies such as GIS is still lagging behind in developing countries, some countries such as Benin, Burkina Faso and Senegal have already understood their importance and the need to do so.

With the support of their Governments and the Technical and Financial Partners (TFP), they have therefore set up GIS, enabling their populations to have quick access to land information and to have management and decision support tools.
However, although the final goal of these tree countries is to secure land tenure by using GIS, the methodological and technological approach that they have developed and adopted differs from one country to another.

While some continue to use traditional methods for collecting socio-land information and property records, others benefit from the many advances in science and technology.

Each of these approaches developed and adopted by these three countries undoubtedly made it possible to achieve the objectives they set themselves, and more specifically to set up an information system that would facilitate access to land for their people, while securing the rights associated with it.

It should be noted, that they all have strengths and weaknesses which reinforces and fills through harmonization of approaches, will not only make it possible to capitalize on the experiences of accompanying the management and securing of land in the rural territories of West Africa and above all a standardization of topo-cartographic and GIS techniques.

After a brief description of the technological approaches used by the three countries and a critical analysis of these approaches, we will set out how their forces could combine to standardize techniques.
1- GEOGRAPHICAL CONTEXT OF THE STUDY

Three countries of West Africa are included in this study:

- Burkina Faso
- Benin
- Senegal
PRESENTATION OF APPROACHES
CASE OF BENIN

Benin, in its political will to ensure secure access to land and to promote economic and sustainable agricultural holdings, has launched for decades, through its government and the support of the TFP, a vast undertaking to realize the Rural Land Plans (RLP).

Therefore, several projects for the development of RLP have over time succeeded and 45 municipalities of Benin are now equipped with a Land Information System (LIS) for the securing and management of their land assets.

- PGRN
- MCA-BENIN
- KFW/FI-AGRI
- PFL
- PRO-PFR

Although the RLP development process is predefined by existing texts, the methodological and technological approaches adopted by each project vary from one actor to another.
Thus, from the implementation of RLP at the village level using the planchette technique in 1992, Benin switched to the use of GPS in post-processing in 2007 and now thinks of implementing a method with a mobile GIS application (5cm accuracy) for the survey of parcels and the registration of rights relating to these plots.
The Plank technique

- The survey of the properties was done using the technique of the plank.
- The land rights were recorded on the basis of fact sheets drawn up in the form of investigation.
- The graphical reports are made directly on the ground and the first graphic documents produced are field minutes carried out by the topographer on surveys on layers of rendered planes, photo plans or ortho-photo plans.
Following the netting done at the office, a second layer is made manually.

For a better retention of the information and especially to facilitate the necessary corrections after the advertisement and the update, the plan is digitized and the information inscribed in the sheet recorded is entered in an Excel file.

**The duration of the work was 6 to 12 months for a village and the accuracy of the data was well beyond the meter.**

These first RLP did not lead to the establishment of a land database or to the development of a LIS.
The implementation in Benin of the "Access to Land", Project of the Millennium Challenge Account and above all the installation of the seven permanent stations have revolutionized the world of cartography and topography with the emergence of GPS as the main data collection tools. From the technique of the plank, Benin switches to the post-processing use of the GPS receiver Trimble GeoXH

- The properties are now recorded on the GPS in association with the permanent station.

*The accuracy of the data becomes submetric with a collection time of around 3 months for one village*
The plot plans are no longer done manually but with the drawing software AutoCAD.

The “.dwg” layers are and then converted into “.shp” to be used by the GIS (QGIS).

The land rights still being recorded on the basis of fact sheets but the information in the Sheets is entered in an Access database.
This time, the RLP work will be completed on the implementation of a LIS that will be used for the issuance of Rural Land Certificates (RLC).
These changes are the result of reflections made by many actors involved in the land to further reduce the time of development of RLP while further improving the accuracy of the data.

- The GeoXH GPS is now replaced by the Navcom SF3040 receiver with CRISP for land recording.

The ortho-images are directly embedded in the mobile GIS application which allows the operator to have an overview of the village territory on the ground.
- The registration of land right will be done via digital forma integrated on windows tablets.

- The intermediate steps (processing of data via permanent stations, realization of plot plans in AutoCAD, conversion of data into a form file, data entry and scanning of the records) are no longer necessary.

**The data collected in the field are directly digestive by the GIS.**

The new RLP database will be modeled and secured using PostgreSQL / PostGIS open source technology.
Several initiatives have been made to equip rural areas with tools for securing their land. For instance,

- The MCA-BF property security project in 2009,
- The current initiative of the National Observatory of Land and
- The PACOF.
MCA-BURKINA-FASO

(47) rural communes have been set up with a SIF to allow the generation of the Certificates of Possession of Rural Land (CPRL).

- This tool consists of an **Access database** to manage the literal data related to the issuance of CPRL, and a cartographic module manages under **ArcGIS**.

  ![Access Database](image1.png) ![ArcGIS](image2.png)

*Unfortunately, with the end of the project in 2014, the spatial component was not finalized.*

The GIS installed at the level of the beneficiary communes of the MCA-BF is therefore not very successful and allows only partial management of the rural land.
THE MAST with the National Observatory of Land

The initiative currently underway to equip rural areas with adequate security tools is experimenting with the technological approach developed in Tanzania using an application called MAST (Mobile Application to Secure Tenure) to secure land.

- It is an online application that enables to record land data and GNSS / GPS points of the parcel using a mobile phone or a tablet;

- This technological approach combines information sources such as satellite images with GNSS / GPS data to remain within the required 3 m accuracy as required by law.

It is an open source

Recording the collected data requires an Internet connection;
Once implemented, the application will allow the automatic editing of field sketches, the output of statistics, and the cartographic visualization (with GeoServer).

However, reflections are under way within the ONF to see how to contextualize this application on the realities of Burkina Faso with for example, the question of hosting basic data, the availability in ortho images of the municipalities concerned.
The PACOF Project for its component 1 initiates the design and implementation of an LIS capable of enabling rural land management with the issuance of CPRL and the digital archiving of land documentation in fifteen (15) municipalities Pilots of Burkina Faso

- The land data will be collected by GPS and the right will be recorded on the basis of fact sheets.

- The system will be developed with open source applications such as PostgreSQL / PostGIS and QGIS.

- The idea of using the cartographic supports ortho images is considered from the experience of Benin.
CASE OF SENEGAL

- Project of Support to the Rural Communities in Senegal River Valley
- MCA-SENEGAL

Project of Support to the Rural Communities in Senegal River Valley

This project was implemented in 2008 with the assistance of the “Agence Française de Développement (AFD)” (French Development Agency).

- The objective was to equip rural councils with tools, procedures and expertise to enable them to manage their area in more effective and transparent manner.

- The land data was collected by GPS and the forms are entered manually.

- The Land Information System that was implemented answers to the followed fundamental question of land tenure:
  - who occupies what space and what are his rights?
  - Where this occupation is located on the basis of a mapping?
The land data was collected by GPS and the forms are entered manually.

The database management system used is postgresql / postGIS with a Chinook platform.

Topographic surveys are made by the national commission to the GPS Garmin 62s with a precision of 3m.
The satellite images are used to enrich the database.

The application has the following features:

- new request;
- Search;
- land register and
- Mapping.

It is fed by direct input and generates the extracts parcels and the duplicates of all the documentation real estate attached to the land procedure.
CRITICAL ANALYSIS OF APPROACHES

The methodological and technological approaches to the implementation of the land security tools adopted by each of the three countries enabled them to achieve the desired objectives.

However, each of these approaches has strengths and weaknesses that need to be analyzed in order to standardize the approaches and technological orientation for future land security projects.

Comments will focus on the latest technological approaches in Benin, Burkina Faso and Senegal.
CARTOGRAPHIC SUPPORTS

The integral coverage of rural areas in satellite imagery, ortho photo or ortho image is a prerequisite and precondition to start land surveys. These supports are excellent tools of communication with the population and allow the extraction of structuring elements or land use.

In the implementation of each of the approaches developed, satellite imagery, ortho-images and ortho-photography have been used.

This is already an advance or a plus to be taken into account by future projects.
THE LAND MANAGEMENT SYSTEM

In the implementation of LIS, the technological approaches developed have all opted for an open-source database management system: the PostgreSQL / PostGIS. The map pane for the most part is also managed by the software GIS QGIS which is also a free application.
TOOLS FOR LAND DATA COLLECTING

The identification of land rights is the essential phase of land security operations. The Knowledge of these rights is obtained through the achievement of land surveys

- identify the different plots of exploitation;
- identify their exploitants and holders;
- specify the nature of the rights exercised by the operators on these lands and register them.

Collection tools differ from one approach to another.
<table>
<thead>
<tr>
<th>Approach</th>
<th>Identification and plot surveys</th>
<th>Registration of Land Rights</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benin</td>
<td>Receiver Namco SF-3040 in conjunction with the Starfire + SIG mobile</td>
<td>Mobile Application (digital files)</td>
<td>- Data accuracy 5cm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Data directly reserved in the SIF</td>
</tr>
<tr>
<td>MAST BF</td>
<td>Mobile phone or tablet (GPS integrated)</td>
<td>Mobile phone or tablet</td>
<td>- Requires internet connexion for data logging</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Sharing information via a web application</td>
</tr>
<tr>
<td>PACOF - BF</td>
<td>GPS navigation</td>
<td>Manually filled forms</td>
<td>- Accuracy of data 3m</td>
</tr>
<tr>
<td>Senegal</td>
<td>GPS Garmin 62s</td>
<td>Manually filled forms</td>
<td>- Accuracy of data 3m</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- Requires the digitization of informations on the forms for data better archiving</td>
</tr>
</tbody>
</table>
### SYNTHESIS OF FORCES AND WEAKNESSES

<table>
<thead>
<tr>
<th>Approach</th>
<th>Forces</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bénin</td>
<td>- Accuracy of data ;</td>
<td>- Density of socio-land information ;</td>
</tr>
<tr>
<td></td>
<td>- Integral coverage of the village terroir ;</td>
<td>- Too long preparatory phase (precisely the ortho realization time) ;</td>
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<tr>
<td></td>
<td>- Imagery embedded in the possibilities for the photographer to have an</td>
<td></td>
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<tr>
<td></td>
<td>overview of the village terroir ;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The properties are directly drawn on the ground ;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The data collected in the field are directly accepted by the LIS</td>
<td></td>
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<tr>
<td></td>
<td>- The time for the collect and treatment of the data is reduced / limited</td>
<td></td>
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<tr>
<td></td>
<td>- Complete data base at the scale of the village terroir ;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Fixe Data update time ;</td>
<td></td>
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<tr>
<td></td>
<td>- Land advertising is lead in a single operation in the territory.</td>
<td></td>
</tr>
<tr>
<td>Approach</td>
<td>Forces</td>
<td>Weaknesses</td>
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</tr>
</tbody>
</table>
| MAST     | - Application smartphone open-source;  
- Easy to use;  
- Cheaper;  
- It is sustainable over time;  
- Uploading of data;  
- Automatic processing of recordings | - Data less accurate comparing to Benin;  
- Requires internet connection for data logging;  
- Requires contextualization compared to the socio-land realities of Burkina-faso |
| PACOF    | - Cheaper;  
- Fast data collection;  
- Complete database adapted to the socio-land realities of Burkina-Faso’ rural municipalities. | - Less accurate/ precise than Benin;  
- Update of deferred data per levy of plot;  
- Topographic survey that is not systematic for the whole village;  
- Incomplete data base on the scale of the terroir |
| Senegal  | - Cheaper  
- Fast data collection;  
- Complete database adapted to the socio-land realities of Burkina-Faso’ rural municipalities. | - Less accurate/ precise than Benin |
Taking into account the strengths and weaknesses of each country approach, it is necessary to harmonize the solutions proposed within the framework of rural land management. To achieve this, it is essential to establish criteria that will facilitate the coherence of technological approaches:

Accuracy - Duration - Reduced cost
Therefore, we have two different tools which give satisfaction to their users.

The precision of the graphic plans is conditioned primarily by the hardware and the measurement tools used.

By using the Garmin 62 GPS and according to their law, Burkina-Faso and Senegal get satisfaction while in Benin, technicians must use for instance GPS Trimble GeoXH and most recently the receiver NAVCOM SF-3040 to reach the requirements of the technical standards.
The time required for the development of rural land security tools varies from one approach to another and depends not only on the duration of topo-land surveys but also on the processing of the data collected.

The method and technique of collection and processing developed by each approach therefore depends largely on the time taken to complete the work.

- While the Garmin 62 allows Burkina Faso and Senegal to work in real time with a positioning time less than one minute per parcel, the GeoXH Trimble used in post-processing in Benin requires a much longer positioning time (at least three Minutes per top of parcel/plot).

- The GPS coordinates recorded by the Garmin 62 are used directly for graphic drawings, while those of the GeoXH Trimble must first be corrected and processed via the permanent stations before being used for the drawing of the plots plans.

The use of the Garmin 62 for the realization of topo-land surveys therefore has the advantage of being much faster than the Trimble GeoXH.
Data collection by the MAST or the NAVCOM SF-3040 receiver displaces the Garmin 62 in terms of rapidity.

- In fact, with the MAST or the NAVCOM SF-3040 receiver, the integrated GIS applications allow the operator to automatically record fields on the ground as polygons by connecting the different GPS points representing their vertices.

- From the tablet or mobile phone, the progress of the work is monitored in real time and the data collected are directly usable by the GIS.
Several elements make it possible to evaluate the cost of developing land security tools: the price of equipment, the fees of the service providers, etc.

*In this present study, only the price of the material will be taken into account*

A classification in ascending order gives:

- The Garmin 62 GPS
- The MAST
- The Trimble GeoXH
- The NAVCOM SF-3040 receiver

The Garmin 62 GPS is less expensive for accuracy of 3m and Trimble GeoXH for an accuracy under 50 cm.

The technology considered by Benin for the development of its future RLP is the most expensive.
### SYNTHESIS

<table>
<thead>
<tr>
<th>APPROCHE</th>
<th>PRECISION</th>
<th>RAPIDITE</th>
<th>COUT</th>
<th>SYNTHÈSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEOXH- BENIN</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>Specific/Precise, slower and expensive</td>
</tr>
<tr>
<td>NAVCOM SF 3040</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>More precise, faster and more expensive</td>
</tr>
<tr>
<td>MAST BURKINA-FASO</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>Less precise, faster and cheaper</td>
</tr>
<tr>
<td>PACOF BURKINA-FASO</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>Less precise, fast and cheaper</td>
</tr>
<tr>
<td>SENEGAL</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>Less precise, fast and cheaper</td>
</tr>
</tbody>
</table>

- An analysis of the approaches in the synthesis on the basis of criteria, allows us to notice that the Navcom SF-3040 envisaged to be used by FI-AGI in Benin and the GeoXH already experienced are more clearly accurate/precise than the collection tools of Burkina-Faso and Senegal.

- In addition to the precision that the Navcom SF-3040 offered, the latter shows the advantage of being as fast as the MAST of Burkina-Faso and even more than the GPS Garmin 62s.
Then a judicious choice has to be made both at the national and regional level by considering the socio-land realities of each country.

From a financial point of view, it seems a little more expensive than the other tools. But in reality, this high cost is not one when the security works are realized at the scale of the village terroir and for a large number of villages.

The acquisition cost of the equipment gets amortized over time with a large coverage of secured land properties since the equipment under warranty of a few years will be used for the completion of several rural land surveys.

The Starfire differential correction solution offered by the equipment is a lifetime subscription once the equipment is functional.

Finally, it should be noted that Benin is opting for the establishment of a single Cadastre at the national level. The content of this technological option remains to be specified.
TOWARD A REGIONAL LAND INFORMATION SYSTEM
The objective is to collect and gather in a unique system, various regional land information produced during the implementation of different tools of land security and to facilitate their consultation and diffusion through an online GIS.

This gathering of data, with the importance of land information will require the definition of a certain management rules also the standardization of some cartographic and topographic standards, in order to avoid an overlap of data.

- What precision seems appropriate for data collection of land?

- Of the 3 m required for instance by the land legislation of Burkina-Faso, Senegal and the isometric precision of Benin, which one allows a better registration of land information and an effective securing of land rights without encroachment?

- Which format is more appropriate for the pooling of data and how to secure their access and diffusion/dissemination?

The standardization of approaches and standards is therefore a very important step for the implementation of a regional GIS.
The harmonization of the approaches will make possible to capitalize on the experiences of accompanying the management and securing land in the rural territories of West Africa, also and above all, a standardization of topo-cartographic technics and SIG based on the forces of approaches already developed and tested;

It should be remembered that this harmonization is already at the scale of UEMOA, ECOWAS in fields such as economic, transport and monetary systems
THANKS FOR YOUR ATTENTION