Spatial Framework in Chad: An Assessment using parts of COFLAS and the MCC Land Records and Transaction Systems Technology Toolkit

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Key words: land administration, spatial framework, Chad

SUMMARY

Chad, which faces pressing land tenure challenges in the context of a backdrop of security, political, and socio-economic crises, is also experiencing significant urbanization. This shift is marked by a growth of informal settlements and the expansion of urban settlements into peri-urban areas. As up to 80% of court cases in the country evolve around intra- and inter-community land disputes, it is important to ensure the security of land tenure in these rapidly growing and expanding areas. Innovative spatial data acquisition methods offer a potential way to secure land tenure and speed up the recordation and registration process. Balancing the preservation of indigenous and customary land practices with the imperatives of modern governance requires tools and frameworks that are both responsive to local contexts and forward-looking.

This paper synthesises the findings of a pilot study in Chad in 2022 using both parts of the MCC Land Records and Transaction Systems Technology Toolkit and the COFLAS to assess the spatial data acquisition methods and draw a vision for the maintenance of a robust spatial framework in Chad.

SUMMARY

Le Tchad, qui fait face à des problèmes fonciers urgents dans un contexte de crises sécuritaires, politiques et socio-économiques, connaît également une urbanisation importante. Cette évolution est marquée par la croissance des établissements informels et l'expansion des établissements urbains dans les zones périurbaines. Étant donné que jusqu'à 80 % des affaires judiciaires dans le pays concernent des litiges fonciers intracommunautaires et intercommunautaires, il est important de garantir la sécurité de la propriété foncière dans ces zones en expansion et en croissance rapide. Les méthodes innovantes d'acquisition de données spatiales offrent un moyen potentiel de sécuriser la propriété foncière et d'accélérer le processus d'enregistrement et d'immatriculation. L'équilibre entre la préservation des pratiques foncières indigènes et coutumières et les impératifs de la gouvernance moderne nécessite des outils et des cadres qui soient à la fois adaptés aux contextes locaux et tournés vers l'avenir. Ce document synthétise les résultats d'une étude pilote menée au Tchad en 2022 en utilisant les deux parties de la boîte à outils technologique des systèmes d'enregistrement et de transaction foncière de la MCC et le COFLAS pour évaluer les méthodes d'acquisition de données spatiales et dessiner une vision pour la maintenance d'un cadre spatial robuste au Tchad.

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1. INTRODUCTION

Land administration in Chad is a multifaceted and evolving domain that plays a crucial role in the socio-economic development of the country. The current state of land administration reflects the complex interplay of historical, cultural, and institutional factors and is governed by legislation developed post-independence, influenced by both colonial and traditional concepts of land. Traditional land tenure arrangements, rooted in local customs and practices, coexist with modern statutory frameworks. This duality poses challenges in terms of legal clarity, as the interaction between customary and formal systems can lead to ambiguities and disputes over land rights. Reportedly, more than 80% of court cases relate to land issues which are often at the root of deadly inter and intra-community conflicts in the country (Codispoti, 2023)

In recent years, there has been growing recognition of the need to strengthen and modernise land administration in Chad. The government's efforts have been strongly supported by international development cooperation. International agencies have worked to address the duality of land tenure, streamline property registration processes, and improve cadastral mapping. These initiatives aim to provide a secure and transparent framework for land transactions, thereby promoting peace, economic development, and investment. However, challenges remain, including decentralisation of land administration, inadequate infrastructure, limited access to technology and a need for capacity building within land agencies.

This paper builds on the previous publications outlining Chad's land administration challenges and project activities (Unger et al. 2023a and Unger et al. 2023b), and goes further into a technical implementation and cost assessment. It aims to evaluate different recordation methodologies trialled during a demonstration in October 2022, ranging from orthophoto-based participatory boundary demarcation to mapping with mobile devices and classical surveying with total stations. By critically assessing these methods, the study will identify which technology options may best suited to Chad's unique challenges and opportunities, based on criteria such as technical performance, practicality, cost and user-friendliness.

2. CASE STUDY IN CHAD

The case study conducted in N'Djamena, Chad, in October 2022, focused on exploring various methodologies for collecting spatial and administrative data, emphasizing partnership and collaboration among different land sector institutions. The case study was organised by Kadaster International together with a Chadian consultant, who facilitated the workshop and the demonstration of technologies locally. Hardware and software for data collection were provided by SmartLandMaps (SLM), Trimble, and Esri North Africa. The University of Twente's ITC provided an online demonstration. Initial stages, including site identification and sensitisation, were conducted exclusively by the local team under remote guidance from Kadaster International. Subsequent stages were executed with the arrival of the international team from October 10 to 14, 2022, involving both office and field work. Five different methods were demonstrated: Demonstration 1 (Conventional Survey): Utilised a total station, carried out by local surveyors as a baseline comparison for other methods. Demonstrations 2 and 3 (Participatory Mapping): Involved using high-resolution satellite imagery on large map sheets for field annotation by community members. The process included discussions on UAV-based data acquisition and various sources of imagery. Demonstration 4 (Field Apps with GNSS): Utilised different GNSS solutions and mobile applications to capture parcel polygons in the field. Trimble Catalyst GNSS and various applications on mobile devices were used. Demonstration 5 (Automated Feature Extraction): Conducted remotely by the University of Twente ITC, focusing on automated feature extraction methodologies using open source and commercial tools. The case study aimed to showcase various methods for collecting spatial and administrative data and to emphasise the importance of collaboration among different entities in the land sector. It involved a combination of theoretical discussions, practical demonstrations in the field, and post-processing work. This case study illustrates a comprehensive approach to data collection and highlights the importance of local and international collaboration in the land sector. It showcases diverse methodologies, reflecting the evolving landscape of land administration and the need for adaptable, collaborative solutions in this field.

3. ASSESSMENT

For the assessment the authors are referencing and utilising the Costing and Financing of Land Administration Services (COFLAS) and the Millennium Challenge Corporation (MCC) Land Records and Transaction Systems Technology Toolkit (LRTS). Both are tools developed for enhancing land administration and property rights systems.

Costing and Financing of Land Administration Services (COFLAS)
Developed through the Global Land Tool Network (GLTN), COFLAS is a decision-support tool designed for policymakers and land administrators. It aims to assist in adopting efficient, cost-effective, and appropriate technologies and methodologies for land administration services, especially in developing countries. COFLAS focuses on modernising budgetary approaches in land agencies, ensuring services are effective, cost-efficient, affordable, and sustainable. It comprises guidelines and a tabular framework for exploring and prioritising land

administration service delivery options. This involves assessing costs, financial resources, human capacity, and strategic decisions like service coverage. It's particularly relevant for reforming land administration services, with an emphasis on affordability and accessibility for all, including the poor (UN-Habitat, 2018).

MCC Land Records and Transaction Systems Technology Toolkit (LRTS)
This toolkit is a joint project of Land Equity International (LEI) and the Millennium Challenge Corporation (MCC) and was developed to provide a framework for assessing and identifying appropriate technology investments specifically for land registration and transaction systems. It focuses on choosing the right level of technology, taking into account the legal and institutional context, existing state and implementation of technology and systems, and capacity and requirements for financing and financial sustainability in a given context. Once a technology decision has been made, planning, procurement and scoping modules are also part of the toolkit. The bottom line is that using the assessment tool should make it easier for development partners (such as the MCC) and government agencies to identify and implement the most sustainable and 'fit-for-purpose' investment option. The LRTS Toolkit is designed in two parts: part 1[1] provides overarching context and guidance for using the toolkit, whilst part 2[2] provides the tools as a set of excel worksheets to support data collection and analysis.

Both COFLAS and the LRTS Toolkit serve to improve land administration systems but differ slightly in their coverage and core area of focus. The LRTS Toolkit is fundamentally an assessment and project design tool, incorporating key elements of COFLAS as individual tools to guide the assessments of potential costs and revenue from a land transaction system. COFLAS, as the earlier piece of work, was intended as a tool for government staff to prepare prepare prosals for land administration system reform, and was not intended as a tool to decide the why or how of reform processes. As such, COFLAS provides significant background data on the experiences of international land authorities in terms of capital and operational expenditures, and provides a clear step-by-step process to guide agency-level proposal preparation, whilst LRTS further develops many of the COFLAS tools, and speaks more directly to development partners, potentially requiring more skilled users (especially in Information Technology) to undertake the assessment. The similarity of the tools largely arises from the involvement of common authors in both.

For this investigation, only some of the assessment parameters on the technical framework from both tools were used to draw conclusions on the technical implementation challenges. Therefore, this research is focusing on a) technical performance and practicability and b) costs and time. It is foreseen with more information gathered in an upcoming project to enhance the assessment and to include more parameters in the future.

The assessment of technical performance and practicability is based on field observations from the recordation demonstrations conducted in October 2022. This evaluation includes

[1] Accessible at: https://www.mcc.gov/resources/doc/toolkit-land-records-and-transaction-systems-technology/
[2] Accessible at: https://www.mcc.gov/resources/doc/template-worksheets-stage-3-5/

considering the reliability of mapping results, positional accuracy, the necessity of physical access to the parcel, and the level of technical expertise required. Additionally, feedback from stakeholders who participated in the workshop was also considered. This feedback was collected through group discussions and documented in notes.

For the analysis of costs and time requirements for collecting spatial and administrative data for a single parcel, the focus is on the human and technical resources needed for operationalising the data collection and mapping activities. Factors considered include the number of teams required, expenses for software licenses, costs for high precision GNSS antennas, and estimated expenses for devices like tablets for administrative data collection. The total cost is calculated on the basis of mapping 50,000 parcels, an arbitrary figure chosen to give a realistic understanding of the costs involved.

4. RESULTS

Technical performance and practicability

Regarding the technical performance and practicability of the land recordation options, this study investigated the reliability, accuracy, effort to access the location of a parcel, scalability and demand for technical know-how by the land recordation facilitator.

	Reliability	Accuracy	Need to walk around the parcel	Scalability	Technical know-how
SmartLandMaps: Sketching plots	Community consensus	Medium	Not necessarily	Yes	Grassroot surveyor*
Mobile Mapping Commercial License and GNSS correction service	Consensus among neighbours	High	Yes	Yes	Grassroot surveyor*
Mobile Mapping Open Source License and GNSS correction service	Consensus among neighbours	High	Yes	Yes	Grassroot surveyor with advanced GIS skills*
Total Station	According to surveying manual but as per law mostly with consensus among neighbours	High	Yes	Yes	Surveyor

Table 1: Conceptual reliability and accuracy of various methods

Reliability and Accuracy: The effectiveness of sketching plots on large scale satellite imagery largely depends on the quality of background images used, as well as the participants' ability to interpret the images/maps (Lindner et al. 2023). Challenges were noted, particularly with recent constructions not being represented on the printed images/maps, leading to some confusion. However, after initial explanations of the limitations of the imagery at hand and the identification of commonly known landmarks, the map understanding of the local community increased allowing the reliable identification of individual plots, particularly in the group setting. The GNSS measurements showed some differences related to the survey accuracy depending on the visibility of correction signals and obstructions by vegetation and constructions. After losing the satellite correction signal during walking or entering houses, several minutes waiting time were needed to reestablish the high precision correction. Some survey points could not be reached and required post processing, e.g. the corner of several detached houses. Overall, a quantification of the final positional accuracy is not possible due to missing cadastral reference data in the area. Thus, the rating reflects general observations during the demonstrations and was also informed by results of demonstrations in other geographical contexts (Stoecker et al., 2022; Bennett et al., 2021; Unger et al., 2019).

Technical Know-How and Training Requirements: The level of technical knowledge required for facilitating the recordation activities varies. For both the recordation using the mobile mapping and paper map sketching, a grassroots surveyor trained for a few days to a week is adequately equipped to use the technology and assist communities in the mapping process in the field. For the option with the open source license of a mobile mapping application, deeper understandings of technical basics of mapping and GIS are required to adequately facilitate preparation and post-processing of the collected data.

Challenges with Participatory and Mobile Mapping: Discrepancies were observed between the results from participatory mapping and mobile mapping. These discrepancies were attributed to factors like outdated satellite imagery, poor resolution, and systematic offsets in the GNSS correction signal. Although these issues were addressed in subsequent updates, they initially affected the field measurements' accuracy.

Limitations with Total Station Results: The data obtained from the total station surveys could not be compared, as they covered different terrains and thus couldn't be directly overlaid or compared with other mapping results. This was due to a last-minute change of the demonstration site.

*In this context the term grassroot surveyor is used in the field of land surveying and mapping, the roles and responsibilities of various levels of surveyors are critical for the successful completion of projects. A grassroot surveyor or grassroots surveyor can perform several tasks independently, but their work often requires assistance and supervision from a professional surveyor, particularly during the preparation and post-processing phases. This collaborative approach ensures that the technical and professional standards are maintained throughout the surveying process. While grassroot surveyor are capable of handling certain tasks, the expertise of a professional surveyor is crucial for more complex aspects of the work, such as planning, data interpretation, and quality control. A practical example of this division of tasks can be found in a project conducted in Nepal (Unger et al. 2019). In this project, a detailed table was developed to delineate the specific tasks that can be managed by a grassroot surveyor or grassroots surveyor and those that require the involvement of a professional surveyor. This table serves as a valuable reference for similar projects, providing clear guidelines on the distribution of responsibilities and ensuring that all aspects of the surveying process are adequately addressed. The Nepal project's approach highlights the importance of leveraging the skills of both grassroot surveyor and professional surveyors to optimize efficiency, accuracy, and overall project success grassroot surveyor By clearly defining roles and tasks, the project ensures that each team member contributes effectively within their area of expertise, leading to more reliable and accurate surveying outcomes.

	Grassroot Surveyor	Professional Surveyor
Training	• Receive training and build confidence and routine through exercising • Able to conduct training after successful completion of training from the professional surveyor	• Conduct training on methodology; identification; image preparation, interpretation and explanation; • Create spatial & cadastral intelligence within the grassroot surveyors
Planning and Preparation	• Organize when and where to conduct communication and data acquisition with the communities	• Organize local and / or national support from governmental agencies (decentralize and central approach)
Awareness	• Build Trust relation with local community	• Show support in the field through governmental representative
Validation	• Conduct validation in the field with the communities	• Train grassroot surveyors on how to conduct an inclusive and gender responsive validation in the field
Data acquisition	• Conduct field work (data collection by drawing on image or using GPS or other data acquisition method), collecting evidence on existing rights through photos of documents, photo of ID and person, • Introduce (communicate purpose and procedure) to HH • Check data in detail after acquisition	• Supervise data organization, data management, tool/hardware management, logistical arrangements • Check data on consistency • Keep the overview
Approach	• Review the approach in regard to local circumstances	• Define the approach
Tools Customization & Manuals	• Review manuals on usability • Use manuals for conducting sensitization and training	• Draft and create manuals • Use existing manual for training purposes for the grassroot surveying • Conduct tools customisation

Source (Unger et al. 2019b)

Costs and time to collect spatial attributes for one parcel

In the context of mapping activities, establishing a standard baseline for cost comparison is essential. The current estimates are based on the mapping of 50,000 parcels per year, with the numbers of teams required adjusted to meet this target. This approach ensures a consistent framework for evaluating and comparing the costs involved in different mapping methods. Each mapping approach necessitates varying numbers of teams and the corresponding equipment, such as tablets and GNSS antennas. This dependency highlights the need for a tailored approach to resource allocation, depending on the specific method employed. However, it is important to note that the costs accounted for only include the collection of spatial information and essential attribute data related to land rights. Excluded costs range from preparation, awareness-raising, travel, salaries, coffee breaks, and the supply of satellite or aerial images, as well as validation and postprocessing activities. For instance, sensitization and validation, crucial for all mapping activities, entail fixed costs that should remain consistent across different methods. This consideration is key in ensuring a comprehensive understanding of the total expenses involved in mapping projects.

	Approx. time for input (min/days)	No. of Teams required (1)	Costs 8 software licences (EUR) (2)	Costs 8 GNSS antenna(s) with high precision subscription (2)	Costs 8 Tablets (3)	Total costs for mapping (EUR)
SmartLandMaps: Sketching plots						
For one plot (minutes)	1.5		1			1.01
For 50000 plots (days …. Euro)	156	1	50,000	none	500	50,500
Mobile Mapping Commercial License						
For one plot (minutes)	15					3.918
For 50000 plots (days …. Euro)	1,563	8	4,400	187,500		195,900
Mobile Mapping Open Source License						
For one plot (minutes)	15					3.83
For 50000 plots (days …. Euro)	1,563	8	none	187,500		191,500
Total Station						
For one plot (minutes)	480					290.90
For 50000 plots (days …. Euro)	400,000	1819		14,545,455		14,545,455

Table 2: Conceptual calculations for various methods and approaches

Some assumptions that were made for the calculation

(1) each team works a maximum of 220 days per year
(2) commercial suppliers offer quantity discounts for the purchase of large quantities of licences and antennas. The table above applies only the list price, average and anonymised, per unit times the number of teams with no discount possible
(3) for the same number of teams (not necessary if teams use their smartphone)

The calculations presented in this context should not be viewed as definitive truths, but rather as a starting point for realistic and constructive discussions. They are intended to serve as a basis for dialogue, encouraging consideration of various methods and approaches used in land administration/mapping. This perspective allows for an open exchange of ideas and insights, fostering a collaborative environment where different viewpoints and experiences can contribute to a more comprehensive understanding with considerations of the local context in Chad.

Technical implementation challenges

Addressing the technical implementation challenges in mapping and land administration systems requires navigating a complex landscape of IT infrastructure issues, government initiatives, and the evolving nature of land data. The existing IT infrastructure in Chad presents significant challenges. Electricity and internet services are both scarce and unreliable, often disrupted by unexpected load shedding. This lack of stable utilities negatively impacts the functionality of computerized land administration systems, causing considerable downtime and inefficiencies. Moreover, the limited and unstable internet connectivity further increases these issues, hindering the smooth operation of these systems. Considering other government initiatives in Chad, there are efforts to implement e-government systems, but these are hindered by a scarcity of resources, especially in more remote and regional areas. This gap between the goals of these initiatives and the actual resources available poses a barrier to the effective deployment and utilization of such systems in Chad. The situation is further complicated regarding available digital land data. Land records, including cadastral data and land registers, exist in a mix of digital and analogue formats, reflecting a transitional phase in data management and digitization. The available maps, especially for areas like N'Djamena, are relatively recent and accurate. The digitisation of land data, initiated with the establishment of a one-stop shop in 2012, continues to encounter challenges, particularly in terms of data backup and security. This ongoing struggle highlights the difficulties in maintaining and updating digital systems in the face of infrastructural limitations. Furthermore, the functional scope of the existing systems reveals their own set of complexities. The land registration system, for example, has undergone significant changes and faced various challenges, leading to the development of new systems like E-conservation in 2023. Access to this data, however, remains limited to specific government personnel, reinforcing institutional silos and restricting interoperability, broader access and transparency. The technology platforms that support these systems also face several issues. The lack of adequate technical documentation, the absence of replacement servers, and the reliance on external service providers for system maintenance and database management highlight the challenges in sustaining these systems in the long term.
These challenges underscore the need for a comprehensive approach that addresses the technical, infrastructural, and administrative factors crucial for the successful implementation and maintenance of effective land administration systems in Chad. This approach should include enhancing IT infrastructure, improving digital literacy, and developing robust system design and maintenance strategies.

5. DISCUSSION

Enhancing the technical implementation of land administration systems in Chad within the frameworks of COFLAS and the LRTS Toolkit offers a structured approach to addressing some of the challenges. COFLAS, with its focus on cost-efficient and sustainable land administration services, provides a valuable guide for Chad in dealing with its infrastructure challenges. This tool can help in assessing the financial feasibility and sustainability of various technological interventions. The demonstration of different technical solutions as presented here help to further assess viable options for the roll out of scalable land administration projects.

By using COFLAS to analyse the costs and benefits, Chad can make informed decisions on investing in such improvements. It also allows for a more structured approach to understanding the financial implications of transitioning from analogue to digital systems, a crucial step in modernizing land administration.

The LRTS Toolkit, on the other hand, offers a comprehensive approach towards technology selection and project design in land administration. Its principles can guide Chad in selecting appropriate technological solutions and designing projects that are also dealing with local challenges such as unreliable electricity and internet. The toolkit's emphasis on sustainability and post-project viability is particularly relevant for Chad. It can guide the country in developing systems that are not only functional under current constraints but also sustainable in the long run.

For instance, the toolkit's focus on digital land data and technology platforms can aid Chad in navigating its mixed digital-analogue landscape and in managing its legacy systems more effectively. It can provide guidance on how to build local capacities for system maintenance, drawing on lessons from countries like Kenya and Uganda.

Moreover, both COFLAS and the LRTS Toolkit emphasize the importance of stakeholder involvement and local capacity building. This aligns well with Chad's need to train local personnel in IT and system management, reducing reliance on external vendors and building a sustainable ecosystem for land administration. However, decisions on the implementation of technological solutions need to be anchored in the present legislative and institutional environment.

In summary, applying the principles and guidelines from COFLAS and the LRTS Toolkit to the context of Chad can provide a structured and sustainable approach to overcoming the technical challenges in land administration. This involves not only infrastructure development and technological upgrades but also capacity building, financial planning, and stakeholder engagement, tailored to the unique context of Chad and its challenges.

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BIOGRAPHICAL NOTES

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