

Image acquisition planning and execution as a foundation for strengthening institutional services for municipal land management and planning: Lusaka, Zambia

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Keywords: land management, peri-urban areas, Zambia, pre-vectorization, image acquisition strategy and execution, municipal spatial planning

SUMMARY

In order to strengthen the Lusaka City Council's (in Zambia) institutional services for a municipal government's land management system and its capacity for spatial planning in the urban and peri-urban territories, Medici Land Governance (MLG) initiated the process with image acquisition planning and execution. This included targeting areas that had been unplanned, with estimated parcels and the strategy sequenced and prioritized. With flight operations and drone technology, MLG was able to produce ortho-rectified imagery of targeted areas. The imagery was used in the pre-vectorization of parcel boundaries, collection of landowner information using mobile data collection tools, rigorous data quality checks for spatial and textual accuracy, supporting community verifications of land records by landowners and communities, and enabling government batch approval. This introduces digital processes in the city departments, including a digital payment system and a central database with necessary detailed land information and data, for land use planning procedures for the city.

The results in the first stages were significant: fully digitized records of 30 offices in the city's peri-urban areas, captured images of 107 square kilometers within the Lusaka jurisdiction, along with the data required to produce and deliver valuations of 34,000 parcels in the valuation registers delivered to the land tribunal by the local government. This enhances the local government's capabilities to manage peri-urban areas, often subjected to dispute and uncertainty. These capabilities include the necessary infrastructure, hardware, and software, modern procedures in place and technical knowledge for land management.

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1. INTRODUCTION

Perhaps the greatest potential impact of leasehold title acquisition is envisioned on a micro-territorial perspective. From the vantage of an individual titleholder, the security of land tenure encompassed in legal rights requires that the individual has a defined area of land not simply boundaries conceived in abstract form because of gaps in accuracy relating to how a parcel is geographically titled. Plainly, the stronger the legality of the title over a specific parcel of land, the standard of precision for the boundaries of that property are firmly established and any subsequent changes can then be properly updated and documented.

In the land governance and systematic titling reforms that are being carried out in Lusaka City and are being rolled out across Zambia, the recognition of the privileges of land use and secure tenure as they arise from the land's economic value becomes central in the city planning of urban and peri urban areas of large city such as Lusaka.

In urban and peri-urban areas, the security of land tenure will prove critical for collateral and economic purposes, especially in communities where there are numerous pockets of informal settlers setting up shelter in areas that are considered suitable for healthful habitable purposes and where the objectives are to reduce the risks and fears of sudden eviction. Likewise, the principle of land tenure security when fortified with administrative and legal backing, and protect communities against arbitrary forced evictions or, where displacement is legitimate and necessary, can at least give them a voice in negotiations for resettlement and compensation" (Oates et al, 2020).

Effective and efficient land governance will be shaped by a collaborative effort that reconciles gaps, contradictions and mismatches by ensuring formal institutions — such as a government's judiciary and administrative authority — operate in accordance with each other and that potentially vulnerable members of the population including women, young people and those with disabilities can exercise their rights while making their own respective household decisions.

The pressure on strengthening institutional services of the municipal governing agencies, authorities and departments in Lusaka has coincided with major shifts in the urban migration of Zambia's population. Rural to urban migration is occurring at a faster rate than ever across the country. According to the CIA Facebook, 45.2% of Zambia's population lives in urban

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areas and the annual rate of urbanization is presently estimated to be 4.15%. This is a significant issue, as greater numbers of residents move to the peri-urban areas near Zambia's largest urban centers, where development and planning will require formalized processes and titles for property purchases.

MLG in Zambia has been providing institutional strengthening services to Lusaka City Government throughout the development and operationalization of a land management system. The overall objective of the project is to enhance the Lusaka City Council's institutional capacities to provide data and toolsets, and knowledge to manage lands under the city's territory, which includes to gain information on land and its values and based on land information enhance spatial planning in the urban and peri-urban territories.

The project has been significantly improving the technical capacities of the city officials, such as the usage of modern digital technologies for land management. The project has four main goals:

- Fully digitize the existing records.
- Introduce digital processes in the city departments, and a digital payment system.
- Have a central database with necessary detailed land information and data, for land use planning procedures for the entire city.
- Increase capacities of the Lusaka City Council to manage the peri-urban areas, including (a) to have the necessary infrastructure, hardware, and software, (b) have modern procedures in place and (c) have the technical knowledge for land management.

With flight operations and drone technology, MLG was able to collect and ortho-rectify collected imagery. The imagery was used in the pre-vectorization of parcel boundaries, collection of landowner information by using mobile data collection tools, rigorous data quality checks for spatial and textual accuracy, supporting community verifications of land records by landowners and communities, and enabling government batch approval,

By the end of 2021, MLG had accomplished the following objectives, thereby setting the pace to accelerate in 2022, especially with additional hardware, software and trained expertise to capture imagery on an unprecedented comprehensive scale. This included producing fully digitized records of 30 offices in the city's peri-urban areas, which were captured, by using drones, of images of 107 square kilometers within the Lusaka jurisdiction. In addition, the imagery captured all of the data required to produce and deliver valuations of 34,000 parcels, which were included in the valuation rolls delivered to the land tribunal by the Lusaka City Council.

The remaining sections of the paper include summaries of observations MLG made in areas targeted for the initial phases of the project, followed by discussions of the process, pre-vectorization and impact of completed work on improvements in municipal services administration.

2. PROBLEM ASSESSMENT

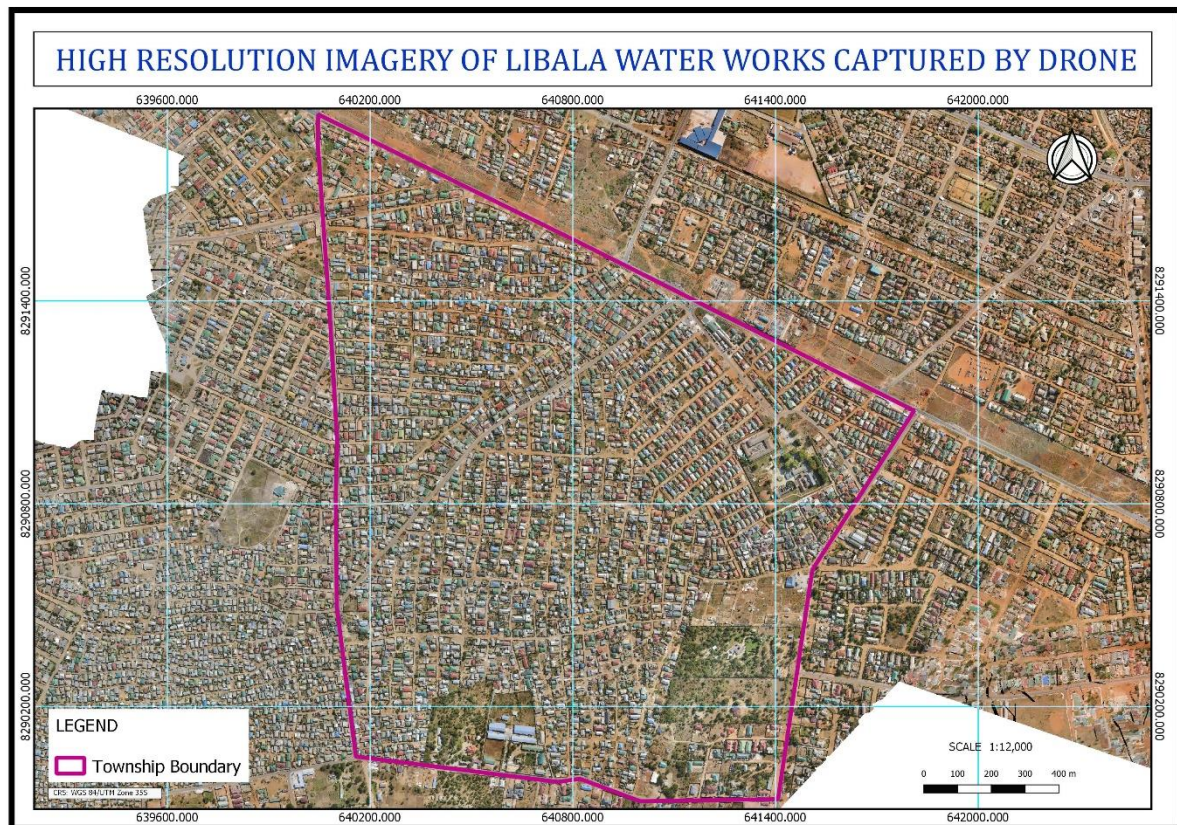
Prior to implementation, in the summer of 2019, MLG staff conducted several observational trips in areas under the jurisdiction of the Lusaka City Council (LCC). These included statutory housing areas and peri-urban areas, defined as an unplanned, informal settlement area under LCC jurisdiction, which is typically characterized by non-conformity to planning. Households in these areas typically have held occupancy licenses or land records documents or in some instances no documentation.

One of the most significant areas of potential for improvement involved the collection of ground rents and taxes. During a visit to the Kanyama/Garden Park Ward Office, it was noted that once properties are entered into the system, the landowner pays a ground rent rate of 18 kwacha per month (equivalent to around 1USD in April 2022) . This entitles the landowner to obtain an occupancy license which provides some security of tenure but there are various challenges with collecting ground rents:

- Many inhabitants are not working or are retired; many women-headed households
- Elderly women struggle to pay ground rents
- Younger generation don't respond to invoices
- No legal repercussions for failure to pay (repossession can be threatened, but is never enforced, which often becomes a political issue)

Meanwhile, at the LCC Site Office, it was observed that a team of six municipal officers deliver bills for ground rent by going door to door. The process is cumbersome, as it can take one month to deliver and less than a quarter of printed invoices were delivered because of staffing inadequacies and landowners must follow several steps to pay ground rents on a quarterly basis. At the time, there were no options to pay with mobile money which is commonly method of payment used in Lusaka City for other services. Also, residents had to go to offices to have any updated information processed manually, but the capabilities for automatically updating any changes would streamline the process significantly for owners.

It was noted during a visit to Libala Waterworks that had been a farm until 2001, but then the LCC distributed land to landowners. The area was surveyed in 2013 and shortly after MLG began operations in 2018, the company discovered that many residents were anxious and ready to secure land tenure by the process of receiving offer letters and title deeds.



MLG reviewed a cadaster, which collected surveyed parcels in Lusaka . The properties were in various stages of the titling process: some were only surveyed, some had offer letters that were still pending and some were fully titled. The cadaster had numerous data gaps, which could have been either lost or not updated by the Survey Department as required. If a property is initially surveyed, then it was determined that there was a foundation for a legal claim. One critical question that had to be resolved was that many people were offered land but had never paid for a title, so the land is just being held.

Property valuation was guided by the Rating Act which the Zambian parliament had enacted in 2018. Three key points from the legislation were that valuation only takes place on titled land, not in peri-urban areas, that only titled properties are “ratable” and that the Lusaka City Council and Ministry of Land and Natural Resources approve the valuation of an area. Surveyors had manually measured new properties, relying on historical data for existing properties and updated every five years. There is an option to publish a supplementary valuation roll to account for any property changes. The valuation rate fees (1% and 2% annually of value for residential and industrial property, respectively) and invoicing process also involved a tedious process in which invoices are delivered by hand twice a year. In addition, valuation variables and calculations were set by common practice, not law. Variables included but were not limited to size of parcel (hectares) size of building as measured in square meters, and floor levels are calculated in square meters and summed together. Lusaka is divided into 40 zones for rating, and each zone has one to two bands. The

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process for rating was tedious, out of date, and costly (roughly \$500,000 USD every 5 years). Meanwhile, revenue streams were incomplete, as only about 65% of property owners were found to pay their LCC taxes in Lusaka (and not everyone even received a bill). Furthermore, there were no penalties associated with failure to pay and the appearance of bailiffs demanding payment was a move that often was successfully rebuffed by residents.

It was clear that a systematic land titling system would improve the rating protocol, and facilitate making properties in peri-urban and statutory improvement ratable. Building on the point on why a substantial segment refused to pay their LCC taxes much less their ground rent, several factors became apparent. Most residents did not have ownership document and when payments were made, the individuals would face long delays in receiving receipts confirming payment, which aggravated the lack of trust in the system. It was found that back taxes totaling \$13.2 million were owed on properties in the peri-urban areas.

In Kanyama, where informal settlements comprise approximately 80% of the area, which also has sections prone to flooding. Most of the targeted properties scheduled to be mapped for titling had the largest arrears in ground rent payments. This made the area ideal for pre-vectorization and physical planning, which then would be followed by providing a shape file to the Department of City Planning at the Council. The team was using ArcGIS and/or qGIS and some departments were utilizing AutoCad. The biggest gap came in the fact that few were using or accessing the cadaster for planning and it was critical that peri-urban areas needed to be regularized for all areas of Lusaka's physical planning initiatives.

In Libala Water Works, another peri-urban area, the process for acquiring an occupancy license was lengthy and involved extensive physical steps, including multiple signatures, verification of occupancy, and an affidavit from the landowner. Likewise, LCC issues titles for *bare land* or *council houses*, with the valuation department setting the price. At the time, bare land was not surveyed so the landowner had to put up the costs for the survey, which ran to 830 kwacha, including 300Kwacha for administrative fees. Likewise, the process also was cumbersome, taking anywhere between two weeks and four months.

In Lusaka, there are 33 statutory improvement areas under the LCC jurisdiction. Occupancy licenses automatically are upgraded to certificates of title, at which point the properties are now permitted to be assessed for valuation and become ratable. Most residents also could not afford to pay the entire amount for documentation fees with short notice so they needed additional time in advance to make arrangements for payments or installments.



Figure 1. Proposed Map for MLG Pilot Project, 2019

3. PROCESS INCLUDING IMAGE ACQUISITION AND PRE-VECTORIZATION

For the project, MLG outlined 13 steps leading from image acquisition planning to issue of certificates of title. The steps include the following:

- a. *Image Acquisition Planning*: Target areas roughly demarcated, parcels estimated, sequenced/prioritized, flight clearance applications submitted
- b. *Image Acquisition Execution*: Approvals granted, establish surveyed ground control and check points, execute flight operations
- c. *Post Processing*: Ortho-rectify (stretch and join) collected imagery to create georeferenced (each pixel has a GPS coordinate) shape files, verify accuracy
- d. *Prevectorization*: Create initial parcel boundaries, create roads, wayleaves etc. according to city planning guidelines, review staff work
- e. *Upload for Enumeration*: Submit shapefile to development team for upload into Enum software, each parcel assigned unique ID
- f. *Enumeration*: Each parcel visited, door to door, by "enumerators", homeowner info (ID, photo of residence, proof of ownership) captured
- g. *Initial Data Review*: GIS team reviews edits from the field, creates draft layout plan & land use plan and community verification map

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- h. *Community Verification*: 14-day period for land owners to review/correct data at a community site, new records captured from those missed
- i. *Final Data Review*: GIS team incorporates edits from Community Verification, creates a final layout plan and land use plan (i.e. plat map), sends to city planning office for approval stamp
- j. *General Plan & Survey Diagrams creation*: Stamped final plan loaded into Enum, general plan with numbered parcels created, individual survey diagrams generated, licensed surveyor signs survey report
- k. *Government Approval*: Area uploaded into Gov Approval app (The National Land Titling System), approved by City Council, approved by Dept. Surveyor General, approved by Dept. Lands
- l. *Offer Letter Issuance*: Offer letters are generated electronically, printed and distributed to land owners
- m. *Title Issuance*: Offer letters followed up with calls and texts, paid parcels are approved by Chief Registrar, titles printed & distributed.

When the pre-vectorization process started for the Lusaka project, MLG used a comprehensive set of data, which included World Bank drone imagery at five-centimeter resolution from 2019, Lusaka aerial photography at 10 centimeter resolution, township shapefiles provided by Lusaka City Council, physical copies of the original approved plans by LCC (in some cases accompanied by a book of standards which includes dimensions for parcels in an area), various GIS datasets for consideration in the planning process i.e. utility lines, drains and streams, protected areas, shapefiles from the 50,000 parcels covered in the pilot project MLG carried out for the Ministry of Land and Natural Resources, the shapefiles from the Ministry's cadaster of titled properties and Google satellite images. Among the steps were georeferencing of scanned maps in the LCC jurisdictions. This was followed by digitization of parcels which uses QGIS workspace to prepare LCC demarcation area shapefiles. These LCC demarcation area shapefiles are then revised to present only the parcels eligible for title under LCC jurisdiction and those which are not covered in the cadastre index (i.e. those parcels titled by the Ministry of Land and Natural Resources).

Subsequently, the parcels with dimensions as given in the book of standards (which in some cases are written on the plan for each parcel) are then created/digitized over the georeferenced plans. It is these files that validate, verify and accurately portray the dimensions and angles of the parcels. The LCC parcel shapefiles are then superimposed to match the layout plan and the digitized parcel shapefile. Once completed, the digitized parcels are then placed over the drone imagery and moved to best match the layout on the ground without altering any dimensions and/or angles of interconnected parcels. The road widths are designated as they are on the original plan. The newly digitized parcels are then assigned the necessary attributes from the scanned maps and /or the GIS LCC data.

MLG has been using drones to take high resolution aerial imagery (10 centimeters) of demarcation areas. The parcel boundaries are digitized by a team of GIS technicians using QGIS. The Ministry of Lands and Natural Resources assists in obtaining "existing spatial data of the demarcation area such as road data, electricity, water and sewerage data, protected

areas, [and] existing cadastral data” (Tembo and Sagashya, 2022). This expedited data requirements to streamline local area planning, building upon the guidelines developed during the pilot project in collaboration with Lusaka City Council and the Ministry of Local Government which oversees physical planning. “It [was deemed] important that every parcel in the demarcation area has access to road and buffer zone, including wayleave, are kept during the physical planning” (Tembo and Sagashya, 2022).

4. IMPACT AND DISCUSSION

In less than two years significant progress has been made. In Lusaka Province, efforts spread rapidly covering the city of Lusaka City, and the districts of Kafue, Chilanga and Luangwa. By September 2021, drone imagery had captured an area nearly one-half the size of the city of Lusaka. Presently, in 2022, the planning team has expanded its capacity for demarcation areas that are ready for enumeration, along with preparing verification maps and maps for approval by the relevant governmental planning authorities. The coordination also has accelerated the latter steps in the process, where offer letters with fully enumerated details on ownership can be presented so that landowners can pay the minimum fee for titling and finally receive a certificate of title. Most recently, the Zambian government approved the Electronic Government Act, which cleared the way for the official use of e-signatures, which will streamline the critical steps in the process leading to the issuance of titles. Below are examples of maps prepared for the municipal planning commission under the jurisdiction of the Lusaka City Council.

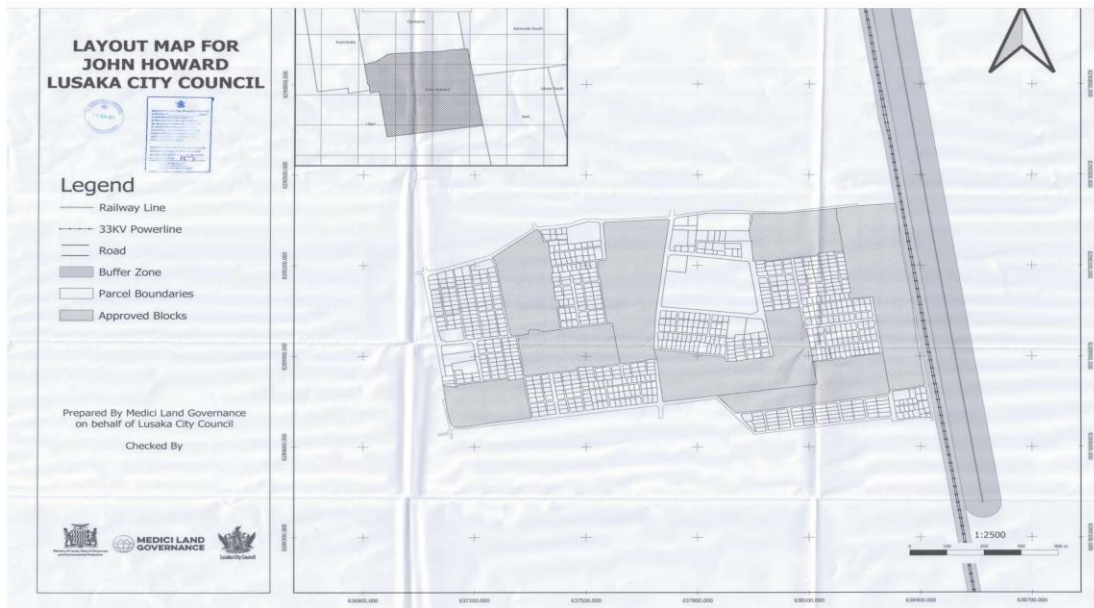
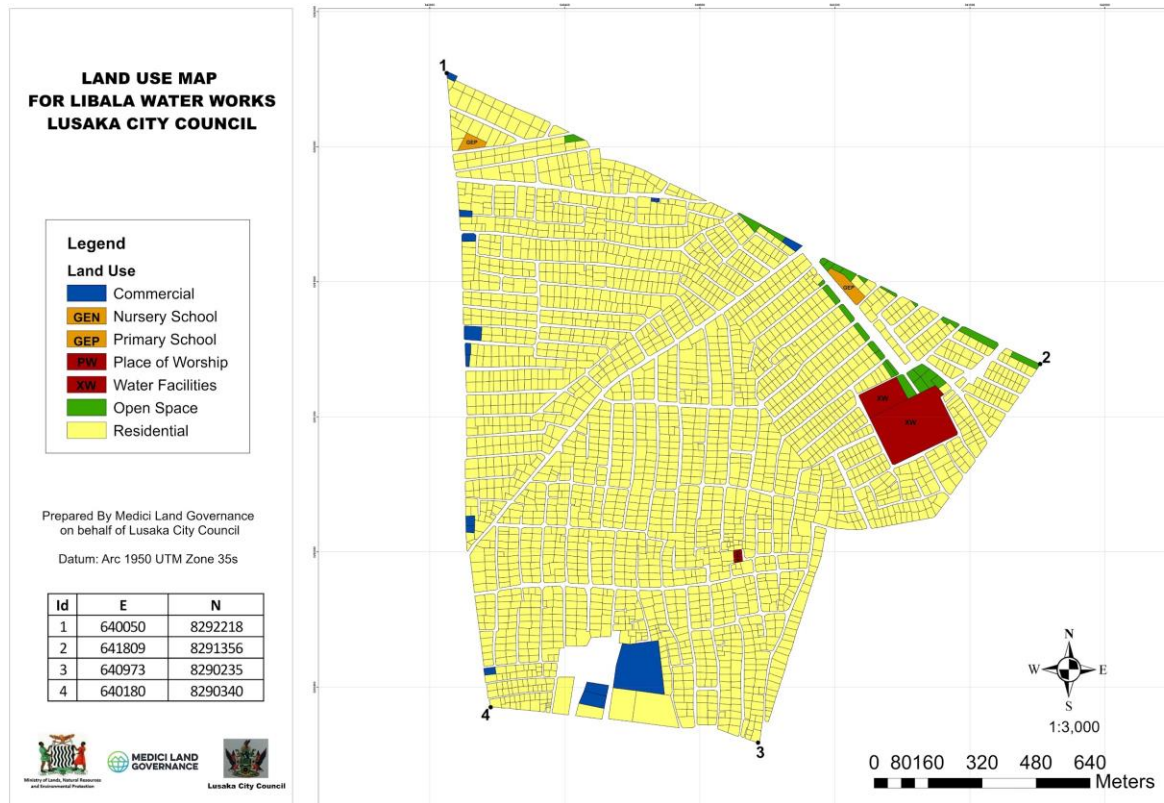


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As for image capture, MLG has enhanced its technological capacity. This includes advanced training for the drone mapping team on Fixed Wing and BVLOS (Beyond Visual Line of Sight) operations. With new hardware (Alti transition Drone) that was delivered in 2021, MLG now has the capacity to significantly increase ground coverage imagery in a single flight and over shorter periods — representing a 60-fold spike from previous capacity. The latest generation of available technology will allow MLG to move quickly in completing major proportions of aerial surveying in areas as the project continues to roll out across the country. Last fall, for example, high resolution aerial imagery had already covered two-thirds of the areas of interests within the Copperbelt, Central and North-Western provinces of Zambia. This translates to 178 square kilometers.

In its five-year national development plan, running through 2026, which coincides with the ongoing systematic land titling project in which MLG is involved, one can readily make the connections to strategic initiatives that focus on delivering essential public services more efficiently and on a basis of where local control is emphasized in municipal governance and planning. For example, one strategic objective articulates improving access to clean and safe water supply. Of note is the following: “Constituencies and wards will be facilitated to identify areas of need for water and sanitation services and plan for the provision of such services to reduce developmental inequalities related to access to social services. Further, the enhanced allocation of the Constituency Development Fund will assist in accelerating investment in the water sector.” Likewise, the government will target financial investment

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into building up infrastructure, based on the information for constituencies and wards, which identify their needs for water and sanitation services. This falls in line with the government's plan to decentralize public service delivery systems across the country.

The data also have proven to be accurate, when examining recorded dispute rates based on fully enumerated land parcels. For example, in September 2021, it was noted that slightly more than 0.25% of 100,591 recorded parcels were being contested, namely because of issues about boundary delimitation and family disputes about legal inheritance claims (Tembo and Sagashya, 2022).

Encumbrances due to existing titles and surveys though remain a concern especially in areas of informal settlement but on properties which have found to be titled. There has been some confusion regarding properties listed in the cadaster index that were marked as not being surveyed but, in fact, were previously surveyed and enumerated for titling. Reiterating the national government's fresh focus on more efficient public services and delivery, it is anticipated that disputes can be resolved more quickly, given the volume of disputes has remained relatively low, going from one area of interest to another.

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BIOGRAPHICAL NOTES

Ali El Hussein, Ph.D., is the CEO of Medici Land Governance (MLG), a company established in 2018. MLG's mission is focused on applying emerging technologies, including blockchain, to empower developing countries' governments at the local and national levels to verify and validate land rights for their citizens and to develop interactive transparent, secure platforms and mobile applications that provide new economic opportunities for landowners.

Didier Sagashya is the Medici Land Governance Zambia Country Manager since September 2019.

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