

# Hybrid Pre-Vectorization Approaches to Produce Accurate, Precise Maps to Scale up Boundary Demarcation for Property Rights Delivery: Case Study in Zambia’s Systematic Land Titling Project

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**Key words:** Access to land; Affordable housing; Cadastre; Cartography; Digital cadastre; e-Governance; Geoinformation/GI; GNSS/GPS; GSDI; Informal settlements; Land distribution; Land management; Low cost technology; Photogrammetry; Positioning; Quantity surveying; Real estate development; Security of tenure; Spatial planning; Urban renewal; Zambia, systematic land titling. land surveying, aerial drone survey imagery, cadastral mapping, infrastructure mapping, modeling, terrain and hydrological analysis

## SUMMARY

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With innovative approaches to pre-vectorization, Medici Land Governance has been able to produce maps with high accuracy and precision, within a few centimeters of their location on the ground. This approach has been successful in the land surveying and mapping stages for Zambia’s Systematic Land Titling Project, which MLG has participated in since 2018.

MLG’s aerial imagery acquisition and post-processing service leverage cutting-edge, high-capacity drone technology with Geographic Information Systems (GIS) software and survey expertise to generate high-resolution orthoimagery and elevation surfaces with positional accuracies within a range of 10 centimeters. The orthoimagery and other data products can be used for many purposes, including cartographic base map layers, cadastral mapping, vegetation mapping (including for agriculture, forestry, or biological conservation), infrastructure mapping, hazard modeling (floods, landslides, wildfire, etc.), and solar PV potential modeling.

As the national rollout (a target goal of delivering 4 million certificates of title by 2027) has expanded rapidly beyond the capital city of Lusaka and the peri-urban areas in the Lusaka province, MLG has surveyed and mapped areas in the country’s Copperbelt, Central, Northwestern and Southern provinces and is now expanding into other areas of the country including the Eastern

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Province.

The process is a hybrid of traditional land surveying approaches with boots on the ground using a survey-grade global navigation satellite system (GNSS) in Zambia and the simultaneous use of drones that fly over areas to capture spatial data. Using the drone and survey-grade GNSS data collected from the field, images are compiled into a survey-grade map with GIS software. Drone imagery also extracts spatial information such as parcel boundaries, building footprints, building elevations, and roads. MLG utilizes machine learning to automate feature extraction and different property mapping elements to significantly increase the scale and speed of boundary demarcation for property rights delivery. When implementing these projects, MLG uses QGIS (open-source) software to share vectorized data with a GeoServer (open-source), combined with special-purpose servers for effective data distribution. MLG has cultivated significant experience utilizing terrain and hydrological analysis tools, including ESRI software, ArcGIS Pro v2.6.0, and QGIS.

The Government has commended MLG for its accurate and efficient land surveying and mapping innovations, which led to the request to map all state land in the country. This is augmented with training on drone mapping and other techniques involving government officials to systematically title land in Zambia.

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