

Mapping Kampala's missing tax base: Satellite data and machine learning for property valuation city-wide

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- Property tax revenues have doubled, but lots of potential revenue goes uncollected. Research by Badalov et al. (2025) shows Kampala Capital City Authority (KCCA) revenues grew from 24 to 58 billion UGX between 2018 and 2024. Yet an estimated 37% of annual liability remains unpaid, and the properties most likely to pay—commercial, high-value, centrally located—are nearly tapped out.
- The next wave of revenue must come from peripheral, residential, and low-value properties that are largely unassessed. The KCCA valuation roll covers only around 165,000 of Kampala's estimated 2.1 million buildings. The 1.9 million unassessed structures are concentrated in the outer divisions and residential areas where the remaining revenue potential lies.
- A satellite-based machine-learning model can now predict property values for every building in the city. By combining KCCA's valuation records with building footprint data, satellite imagery, road networks, electricity infrastructure, and neighbourhood characteristics, we produce the first building-level property value map for the full Greater Kampala Metropolitan Area. The model performs well enough for policy use.
- The map directly addresses the structural challenges Badalov et al. identify. A complete building-level map enables KCCA to expand and equalise the tax base, supports more accurate and progressive revaluations, helps target compliance outreach to unregistered properties, and provides evidence to guide future rate-band policy design.

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The challenge: A revenue system at a structural turning point

Property rates are Kampala's most important source of own-source revenue. Under the Local Governments (Rating) Act 2005, the Kampala Capital City Authority (KCCA) assesses, bills, and collects rates based on the estimated annual rental value of each property. Since 2019, when the city completed its first comprehensive valuation across all five divisions, revenue has grown impressively; annual collections roughly doubled between 2018 and 2024, reaching 58 billion UGX (Badalov et al., 2025). This is a genuine institutional achievement.

Yet a recent International Growth Centre (IGC)-funded analysis of KCCA's tax records reveals that the system is approaching a structural ceiling. The revenue gains of the past five years were driven by a specific set of properties: those in the Central division and Nakawa, commercial buildings, and the top few properties by assessed value. These properties now contribute 60% of total revenue while representing less than 3% of the tax roll.

The remaining uncollected potential—estimated at 37% of annual liability, or roughly 34 billion UGX—lies almost entirely elsewhere: in the outer divisions of Makindye, Kawempe, and Rubaga; in residential rented properties; and in the large majority of buildings assessed at low rateable values. These are the properties from which KCCA has historically struggled to collect, and they face the lowest compliance rates. As of 2023-24, 78% of properties in the KCCA focus sample had never made a single payment across the five years studied.

There is, however, a more fundamental problem that sits beneath the compliance challenge: the tax roll itself is dramatically incomplete. The KCCA valuation roll covers approximately 165,000 buildings—around 8% of Kampala's estimated 2.1 million structures. The remaining 1.9 million are unassessed and entirely invisible to the fiscal system. Without knowing where these buildings are, what they look like, or what their likely value might be, KCCA cannot systematically extend the tax base or direct outreach to where it is most needed.

What we did: A complete building-level property value map

Working with KCCA's GIS Department and with support from the IGC, we trained a machine-learning model to predict the assessed property value of every building in the city — including the 1.9 million not yet on the valuation roll.

The model — a gradient-boosted decision tree (LightGBM) — learns from the 165,000 buildings with official KCCA assessments. It identifies which physical and locational features best predict value in the areas where data exist, then applies those patterns city-wide. Predictors include:

- **Building characteristics**: footprint area, perimeter, compactness, estimated height, and detection confidence (Google Open Buildings v3).
- **Satellite signals**: nighttime light intensity (VIIRS), vegetation cover (Landsat NDVI), and ground elevation (SRTM).
- **Road and amenity access**: distances to primary roads and to schools, hospitals, hotels, restaurants, grocery stores, and transport hubs (OpenStreetMap).
- **Neighbourhood context**: mean building size, height, and nighttime light across the 100 nearest buildings.
- **Infrastructure access**: distance to low- and high-voltage electricity distribution lines (UMEME network).
- **Environmental features**: distance to wetlands and lakes.

All 60 predictor variables are extracted at the individual building level. The model is cross validated to ensure results generalise to unseen buildings rather than merely fitting the training data. It correctly ranks buildings by value in 72 out of 100 cases (Spearman $\rho = 0.72$) and explains 51% of the variation in assessed rates (cross-validated $R^2 = 0.51$). For comparison, a Random Forest model trained on the same data performed worse on both metrics.

The resulting map covers not just KCCA's 195 km² administrative area but the full 5,143 km² Greater Kampala Metropolitan Area (GKMA)—including Kira, Nansana, Makindye Ssabagabo, Entebbe, and Mukono—with predictions for all 2.1 million buildings. It is the first city-wide property value surface at the individual building level for Kampala.

What the map reveals

The map confirms familiar patterns and uncovers less obvious ones. The highest predicted values cluster along major arterial roads and in the central business district—consistent with the revenue data in Badalov et al. showing Central and Nakawa as the dominant contributors to date. Dense clusters of low-value buildings in the interior and periphery correspond closely to known informal settlements and areas of low compliance.

More importantly for policy, the map makes visible the economic geography of the unassessed city. Pockets of relatively high predicted value appear well outside the urban core, in areas where access to local amenities and neighbourhood density drive value even in the absence of formal assessment.

These are precisely the areas where expansion of the tax base could yield meaningful revenue without the enforcement challenges associated with the very lowest-value residential properties.

The parish-level choropleth—aggregating predicted values across 379 administrative units—provides a neighbourhood summary that planners can act on directly, identifying where investment deficits are largest relative to economic potential.

Figure 1: Predicted property values – Kampala

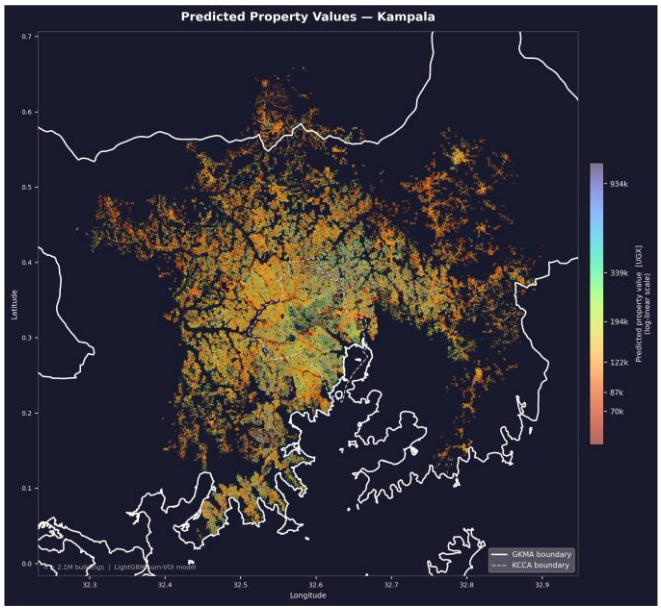
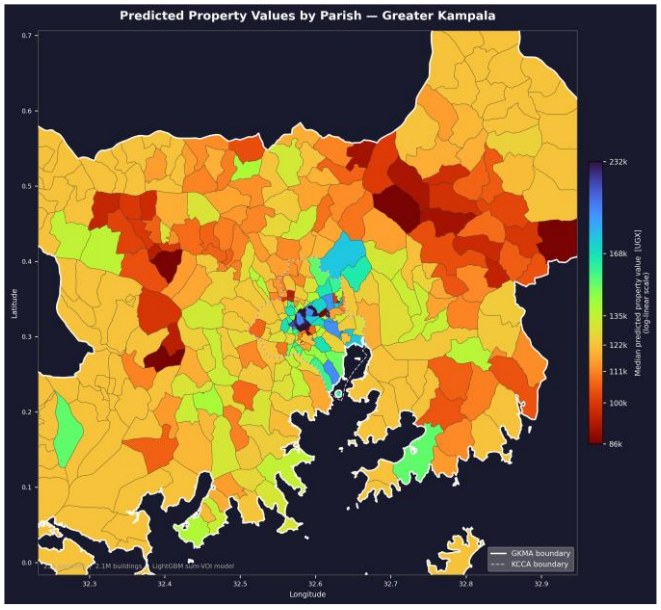


Figure 2: Predicted property values by parish – Greater Kampala



A note on uncertainty: predictions within the KCCA boundary are grounded in local observed data and are the most reliable. Predictions in the wider GKMA carry greater uncertainty and should be treated with corresponding caution. The model is also best used as a ranking and targeting tool; absolute predicted values at the extremes of the distribution are subject to regression-to-the-mean compression.

Policy implications

Badalov et al. conclude their analysis with three key recommendations: target lower-value, residential, and peripheral properties; align billing practice with the eligibility rules of the rates bands policy; and lower barriers to valuation court access for low-value properties. A complete building-level map is a direct enabling tool for each of these.

Extending the tax base to peripheral and residential properties

The single largest structural gap in KCCA's fiscal base is coverage: 1.9 million buildings—mostly in the outer divisions and residential areas where Badalov et al. show that most remaining revenue potential lies—do not appear on the valuation roll at all. The building-level map gives KCCA, for the first time, a ranked list of which unassessed buildings and neighbourhoods are most likely to have meaningful taxable value. This allows outreach and enumeration efforts to be targeted rather than blanket, concentrating scarce field capacity where the return is highest.

Targeting compliance outreach where non-payment is most recoverable

Badalov et al. show that even among properties already on the roll, 78% had never made a payment over the five-year study period. The map allows KCCA to cross-reference the valuation roll against satellite-visible building stock, identifying properties with meaningful predicted value that have been persistently non-compliant—and distinguishing these from genuinely low-value structures where the cost of enforcement may exceed the revenue yield. This kind of targeted, evidence-based compliance strategy is more likely to improve collection rates than broad-based campaigns.

Urban planning, poverty analysis, and infrastructure investment

Property value is a strong correlate of household wealth. The map complements household survey data by providing a high-resolution, continuously available signal of economic conditions at the neighbourhood and street level—valuable in the years between major surveys. Low-value building clusters are strong indicators of informal settlements and can help planners target slum upgrading programmes, affordable housing initiatives, and basic service extensions more precisely. Investment in roads, drainage, water, and electricity can be directed to areas where the infrastructure gap is largest relative to the underlying economic potential.

Looking ahead

These results are a starting point. Three priorities would substantially improve the usefulness of the approach:

- **Extending training data beyond KCCA.** The model was trained exclusively on buildings within KCCA's administrative boundary. Commissioning valuation data for a sample of buildings in surrounding municipalities—Kira, Nansana, Wakiso—would allow the model to be validated and retrained for the wider metropolitan area, where predictions currently carry greater uncertainty.
- **Including large and multi-storey buildings.** Buildings with a footprint above 500 m² or a height above six metres are excluded from the current model because the training data for these types is too thin to support reliable predictions. As KCCA's valuation roll is extended to cover more commercial and multi-storey structures, these can be incorporated.
- **Periodic updating.** Most of the geospatial inputs—satellite imagery, building footprints, OpenStreetMap—are regularly refreshed. Establishing a pipeline to re-run the model as new data becomes available would transform it from a snapshot into a living instrument, enabling KCCA to track urban expansion, identify newly constructed buildings, and monitor how infrastructure investment affects property values over time.

Beyond Kampala, the approach is replicable wherever a property valuation roll can serve as training data. Other Ugandan cities—and eventually a nationwide rollout—could draw on the same globally available satellite and geospatial inputs to build equivalent maps, providing the central government with a scalable tool for monitoring urban fiscal capacity across the country.

Related research

This brief draws on two complementary IGC-supported research streams:

- Sohnesen, Fisker, Musisi, Bakaki, Edyegu & Orjuela Pava (2025). Predicted Property Values for All Buildings in Kampala. Working paper. Develops and validates the satellite-based LightGBM prediction model and city-wide property value map described in this brief.
- Badalov, Mutebi, Ravindranath, Regan & Ssebuwufu (2025). Property Tax in Kampala: Revenue Collection, Progressive Rate Bands, and Valuation Appeals. IGC Final Report UGA-24171. Analyses KCCA payment records, the rates bands policy, and Central division revaluations and court outcomes from 2019 to 2024.

Data and methodology note

Training data: KCCA Property Valuation Roll (2025), collected through the City Address Model and Computer-Aided Mass Valuation (CAM/CAMV) project under KIIDP 2 (World Bank). Building footprints: Google Open Buildings v3 (2023). Satellite imagery: VIIRS Nighttime Lights v2.2 (NOAA/EOG, 2022); Landsat 8/9 NDVI composite (USGS/NASA, 2023); SRTM DEM (NASA/USGS, 2000) — all via Google Earth Engine. Roads and amenities: OpenStreetMap (2024). Population: LandScan (ORNL, 2022); WorldPop (2020). Electricity grid: UMEME Ltd (2024). Wetlands: NEMA Uganda (2020). Urban classification: Africapolis 2025 (OECD/SWAC). Administrative boundaries: Uganda COD (OCHA); GKMA 2023 (KCCA). Model: LightGBM gradient-boosted decision tree. Training sample: 165,167 buildings. Cross-validated $R^2 = 0.51$; Spearman $\rho = 0.72$.