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Modelling Improvements to Property Tax Collection: The Case of Addis Ababa

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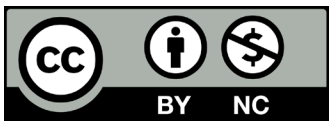

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Tel: +44 (0) 1273 606261
Email: info@ictd.ac
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Summary

Efforts to reform property tax systems in African cities tend to focus more on how to value properties for purposes of tax assessment than on how to better collect taxes due. The same is true of the literature on property tax reform. There is however reason to believe that a greater initial focus on improving collection would be more productive. In this paper, we explore how this might be done in Addis Ababa. This would involve adopting a principle already employed in several African cities: area-based property valuation. This involves linking the tax assessments of individual properties closely to assessments, neighbourhood by neighbourhood, of the quality and density of the available basic public infrastructure and the quality of the built environment. We demonstrate how to identify and map neighbourhoods for this purpose.

Keywords: property tax, tax collection, spatial analysis, infrastructure, urban development, Africa, Ethiopia.

Gabriella Y. Carolini is an Associate Professor of urban planning and international development at the Massachusetts Institute of Technology (MIT). Her research examines the governance and evaluation of urban infrastructure development across cities in Sub-Saharan Africa, Latin America, and North America, with a focus on the financial architecture of water and sanitation projects. Gabriella has advised and worked with several international organisations, including the UN Economic Commission for Africa, UN-Habitat, UN Economic Commission for Latin America and the Caribbean, and the Japanese International Cooperation Agency. Her work is published in a broad range of academic journals, including the *International Journal of Urban and Regional Research*, *Urban Studies*, *Environment and Planning C*, *The Lancet*, and the *American Journal of Public Health*.

Fitsum Gelaye is an urban development professional with a background in environmental design and planning. She holds a Master's in City Planning from MIT, where she focused most of her work on water and sanitation access in developing cities. She is currently working as a consultant on water resilience in rapidly urbanising African cities and as an adjunct assistant professor of urban design at Columbia University.

Kadeem Khan is currently a researcher on Facebook's Data for Good (D4G) team. Prior to joining the D4G, he was a Master's in City Planning student at MIT where he concentrated on international development and data science. His work is focused on leveraging data science and geographic information systems for global development.

The African Property Tax Initiative (APTI) is supporting robust, policy-relevant research to boost wider use of more effective property tax systems in Africa. www.ictd.ac/network/apti/

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Acronyms

AACA	Addis Ababa City Administration
AACPPO	Addis Ababa City Planning Project Office
AAWSA	Addis Ababa Water and Sewerage Authority
ETB	Ethiopian Birr
IPTN	Infrastructure-property tax nexus
MUDC	Ministry of Urban Development and Construction
OSM	OpenStreetMap
VIIIRS	Visible Infrared Imaging Radiometer Suite

Introduction: meeting the costs of urban infrastructure needs

With the urban population boom arriving on the continent, African cities are increasingly pressed to efficiently and effectively improve current living conditions and plan for greater population and economic growth through infrastructure development. Capital investments in urban public infrastructure are therefore key to navigating African urban futures. Such investments are typically financed through four windows: a government's own financial resources, loans, public-private partnerships, and – in some regions – land value capture (Paulais 2012). While national governments sometimes contribute directly to the budget of (especially iconic) urban infrastructure – for example, through the establishment of a development authority of which they share ownership[1] – fiscal and administrative decentralisation can mean that local governments are made responsible for building new or expanded public infrastructure systems. In these cases, local governments' financial resources become critical, providing direct financial contributions to project budgets as well as a means of securing other resources such as loans. Within the African context, municipal governments are most heavily dependent on intergovernmental transfers and concessional loans channelled through central governments or financial intermediaries (e.g. development authorities) from multilateral financial organisations (e.g. African Development Bank and World Bank) or bilateral donors (Fjeldstad and Heggstad 2012). Contrarily, local government resources from own-source revenues like the property tax are widely viewed as the most underutilised funding stream among local authorities across the continent (Fjeldstad and Heggstad 2012; Franzsen and McCluskey 2017). Indeed, property tax revenues sit at a much lower percentage of gross domestic product in low-income African countries than in low-income countries in other regions, according to a recent study by Franzsen and McCluskey (2017).

Given the low performance of own-source revenues relative to other financial resources available to local authorities, much scholarly attention over the past two decades has emerged, targeting the question of how to improve property tax performance in African cities. The recent rise of African real estate development as a major investment vehicle has made this question especially pertinent (Fjeldstad, Ali and Goodfellow 2017; Goodfellow 2015, 2017; Watson 2014). Research themes in this area point to three challenges in the implementation of reforms: administrative obstacles, technical difficulties, and political resistance to reforms.

Administratively, local authorities' legal rights and capacities vis-à-vis their central government represent a major concern of scholars and practitioners across the continent. Several African cities are hamstrung by small or weak administrative units that have neither the training nor the support to pursue fiscal reforms and implement them (Turak 2017; Franzsen and McCluskey 2017; UN-Habitat 2017). Because of this reality, technically-oriented research proposals for the acceleration of fiscal reforms such as the modernisation of the property tax have often centred on facilitating less administratively arduous implementation strategies. For example, area-based valuations have been promoted across Africa because of the relative simplicity of the assessment process compared to market-based valuations of properties that require more specific data and frequent cadastre updates on registered properties (Bahl, Martinez-Vazquez, and Youngman 2008; Franzsen and McCluskey 2017). Political obstacles to property tax reform and implementation, namely

[1] For example, in the Mozambican capital Maputo, the central government owns a public enterprise, the Empresa de Desenvolvimento de Maputo Sul (or Maputo Sul), which is charged with overseeing infrastructure development and physical planning in one of the city's largest, yet still mostly rural, municipal districts. Development therein includes the long-anticipated bridge – what will be Africa's longest suspension bridge – connecting the district with the city's business centre (Carolini 2017).

resistance from residents as well as from local tax collection authorities themselves, represent a third subject of research. In some African countries, such as Mozambique, 'house tax' payments are strongly associated with the recent colonial experience, and thus attempts at the renewal or enhancement of property taxes there – as likely elsewhere on the continent – face particular cultural and historical obstacles (Havik 2013). In addition, residents' perceptions of the fairness and benefits of such taxes matter in terms of their willingness to pay, as does their trust in government to deliver promised improvements (Prichard 2015). Franzsen and McCluskey (2017: 97) note that taxpayer morale is often low in many African countries because of a lack of trust in local councils and because of perceptions of the 'non-existent or poor-quality local services in return for property tax payments'.

Limited work within these aforementioned property tax literatures, however, centres on how to improve property tax collection within African cities, though the collection ratio is acknowledged as one of the key measures of administrative efficiency and capacity for property tax system upgrades. Indeed, leading tax scholars have argued that advancing property tax collection efforts *before* updating property valuation may be key to successfully modernising property tax systems on the continent (Franzsen 2018). Powers (2008) also explains that because property tax revenues will likely be rather low in early phases of reform, relative to other financial resources in low-income contexts, incentives for local authorities to work on collection improvement should be more than the actual value such revenues would represent to the local budget during those initial phases.

The rest of this paper seeks to help address the current literature gap on improved tax collection by modelling the possibility of formalising a linkage between taxpayer perceptions, local services, and property tax payments. We ask: what are the readily accessible parameters through which property tax collection strategies can be advanced within the context of a rapidly developing urban landscape within Africa?

As Bird and Slack note, public accountability requires more than community knowledge about what local governments do and how they pay for it: 'It also requires that such information is sufficiently understandable so that at least a critical margin of voters can understand what is really going on' (2014: 365). In this paper, we contend that infrastructure itself could be a key resource for enhancing property tax systems. This is because infrastructure's materiality speaks to the 'comprehensible' point raised by Bird and Slack (2014), but also because infrastructure services provide a mechanism through which property tax collection can be explicitly enhanced. It is this latter role – that of infrastructure services as a mechanism by which to also collect property tax payments – that is critically explored in this paper.

Evidence in South Africa already points to how creating a linkage between infrastructure fees and property taxes due may be fruitful. Overdue taxes, for example, have been successfully collected through connecting tax payments with infrastructure services provided (Franzsen and McCluskey 2017: 94). While necessary safeguards should be put into place to ensure that the most vulnerable populations are not further burdened with life-threatening risks from infrastructure service cut-offs, the example highlights how linkages with material services help establish a connection between the utility of property taxes and the services that cities provide in the public imagination.

While infrastructure access is already inherently or explicitly included in most property *valuation* methods, infrastructure access is not as often tapped as a mechanism through which to enhance property tax *collection*. The success of an infrastructure-property tax or fee linkage, as with other fiscal administrative reforms, will be highly dependent on the design of the actual linkage *and* how well that design accounts for contextual factors that complicate a simple transfer of payment or fee collection. A recent study of the waste sector in Addis

Ababa underscores this point. Data collected in 2011 show that the city's residents were willing to pay for improved liquid waste treatment – *if* the quantity and quality of treatment were improved (Woldemariam, Seyoum and Ketema 2016). While of course socio-economic status affects the scale of payment, the study stresses the potentiality and criticality of ensuring that infrastructure upgrades and improvements link with residents' financial contributions – both as a mechanism for improving perceptions of the fairness of fees, but also as a process to enhance trust between residents and governments. Following from Woldemariam *et al.*'s 2016 willingness-to-pay study in Addis Ababa, we use the Ethiopian capital for empirical evidence to model a method for ascertaining how local authorities could begin to phase in the introduction of a pilot system for linking property tax payments and infrastructure service fees. Addis Ababa provides an ideal site for exploring this potential for several reasons.

Over the past two decades, Addis Ababa City Administration (AACA) has witnessed a significant construction boom (Goodfellow 2015, 2017). In recognition of the affiliated potential for greater own-source municipal revenues from this build-up, the AACA has taken on several administrative policy interventions – most notably, repeated efforts to effectively modernise the property system in the city. In 1996, a major census of all properties in Addis Ababa was undertaken and led to an update of property values based on the estimated annual rental value (MUDC 2013). Property owners strongly objected to the recalculated value of properties, however, so much so that the government essentially reverted property values to their original amounts (MUDC 2013; Goodfellow 2015). Nonetheless, in 2009, the AACA put out a new tender to secure help in the development of new real property registration, an updated cadastre, and a street addressing system. A German geospatial information company, Hansa Luftbild, won the bid for the EUR3 million project and developed these systems with AACA. Using aerial photography covering all ten of Addis Ababa's sub-cities, Hansa Luftbild mapped 360,000 parcels of land and 1.15 million building or construction features (Chatfield-Taylor 2014). The geospatial information firm also worked to ensure decentralised access to the new management system and trained authorities at the city and sub-city levels of government in Addis Ababa. Furthermore, the digitised property information system was built recognising the constraints of Addis Ababa's extant telecommunications network (Zein, Hartfiel and Berisso 2013; Chatfield-Taylor 2014). In short, many administrative and technical obstacles to the modernisation of the property information system were addressed. Yet several years later, the city administration reported that property registration still remains incomplete (UN-Habitat 2017, citing an AACA 2016 land management report). The city currently still levies a roof (or city house) tax, which is in theory based on the annual rental value of a property, and the closest approximation to a property tax in Addis Ababa. However, Ethiopia's Central Revenue Authority is now charged with collecting these taxes (Goodfellow 2015; UN-Habitat 2017).

If roof taxes are to be collected again by the AACA, municipal authorities will need a strategy for how to improve upon past performance by addressing the political challenges to the implementation of reform. This paper aims to explore the potentiality of one such strategy to diminish the anticipated political resistance of residents – namely the linking of infrastructure service billing with property tax billing in areas of the city where infrastructure services are a strong testament to the public sector's capacity to deliver.

1 Methods

In keeping with the administrative practice within cities of zoning different land uses, demarcating continuous (as well as discontinuous) land zones in municipalities to raise revenues and incentivise local economic development (such as enhanced infrastructure

finance districts, tax increment finance districts, special enterprise zones, etc.), this paper explores whether the demarcation of physical zones within a municipality can facilitate the phased introduction of improved property tax collection. More specifically, just as property tax systems across several African countries have adopted area-based valuations, here we envision area-based collections – where property tax collection mechanisms (as opposed to valuation rates) would differ by area, as a function of that area's basic infrastructure services and built-up environment. In such an effort, the zone with the highest density of infrastructure services would be designated as a prime candidate for the introduction of linked property tax and infrastructure services billings, whereas properties within a zone with lower infrastructure services would continue to collect property tax in separate billings from infrastructure service bills.

In order to create a zoning typology for area-based property tax collection, we first determined which sub-city within Addis Ababa would provide the greatest variation across land in basic infrastructure services – from densely located and advanced basic services (e.g., services typically required for the construction of high-rise buildings, like road access, water and sanitation, and energy) to less advanced basic services (e.g., intermittent access to water or unsewered sanitation in low-scale housing, etc). To that end, we collected data from 2010 and 2017 of building profiles in Addis Ababa to verify and visualise specific areas within the city that have witnessed intense shifts, or a 'construction boom', in their built environment. Key to our visualisation was the effort to maintain key distinctions in the building data we collected, namely by maintaining separate identifiers for high-rise buildings[2] and single-family homes. This departs from several other recent geospatial analyses that leverage satellite imagery, but only to digitise building footprints and roads across several African cities; these analyses include efforts financed by Facebook, Google, and the World Bank. Cognisant of Hansa Luftbild's extensive work on digitising parcels and buildings throughout the city, our efforts also sought to move toward the next step of qualifying those buildings which had been built since 2010 within one sub-city of Addis Ababa as a demonstration case for how to demarcate a typology of administrative zones in which the mechanism through which the 'roof tax' (as a proxy for future property tax in Addis Ababa) is collected might be differentiated (i.e., collected through a combination with infrastructure service bills or separately billed).

To select a sub-city for this pilot, we sought data to identify where a construction boom and active real estate markets converged with existing infrastructure. To this end, several major data sources were leveraged:

1. Construction permits issued by AACA;[3]
2. Active real estate brokerage permits by sub-city;
3. Satellite imagery of Addis Ababa in 2010 and 2017;
4. Rental and sales data for single-family homes and apartments listed with major online realty brokerages;
5. Night-time light emissions from the Visible Infrared Imaging Radiometer Suite (VIIRS);
6. Geo-locations of existing sewerage lines (Addis Abba Water and Sewerage Authority);
7. Road networks in Addis Ababa from OpenStreetMap (OSM).[4]

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[2] By 'high-rise buildings', we mean buildings with at least three floors. A major limitation of this approach remains the inability to ascertain from satellite imagery whether high-rise buildings are commercial, residential, or mixed. However, as our focus is on piloting an experiment in tax collection as opposed to property valuation, this limitation does not have significant relevance for our method for identifying pilot administrative zones for adjoining infrastructure fees and tax payments.

[3] While we have construction permit data since 2002, we are missing data between 2012 and 2014. Data between 2002 and 2011 was referenced from handwritten ledgers, while data since 2015 has been digitised.

[4] https://www.openstreetmap.org/#map=6/54.910/-3.432

Based on this data, as described in more detail below, we chose to focus our pilot exploration of modelling area-based property tax collection via the linking of property/roof tax and infrastructure fees in Bole sub-city – one of ten sub-cities in Addis Ababa – representing roughly 122 square kilometres with a population density per square metre of 2,694.[5] A spatialised index was then created by combining the aforementioned data in order to identify zones within Bole that would be prime candidates for adjoining the billing and payment of infrastructure service fees and property/roof taxes, as well as zones where such a collection strategy would not yet work given the low density of infrastructure services available. The paper's conclusions consider the potential opportunities for implementing this strategy, as well as limitations of our spatialised model, and of course next steps in research.

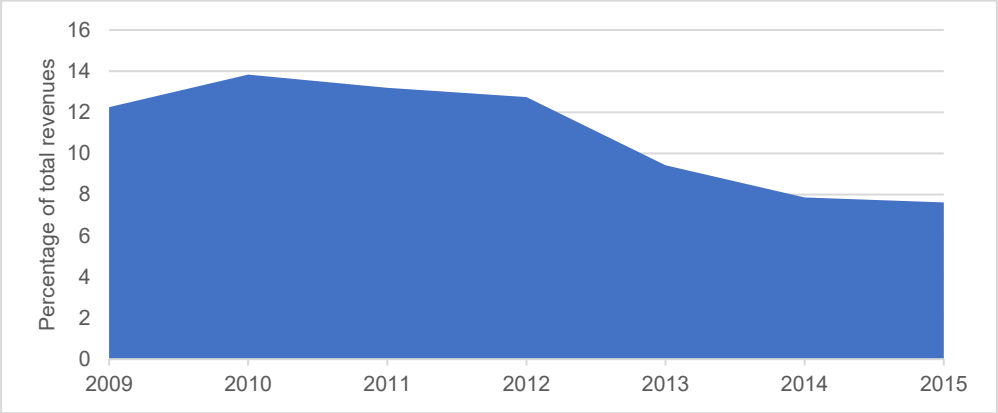
2 The case of Addis Ababa: linking urban growth, infrastructure, and own-source revenues

While still largely rural, Ethiopia is one of the fastest urbanising countries in the region. The urban proportion of annual population growth in the country was over 50 per cent between 2007 and 2015 (Schmidt, Dorosh, Kedir Jemal and Smart 2018). Secondary cities represent some of the most rapidly changing urban landscapes in the country, but Addis Ababa remains its largest urban hub, with a steady annual rise in residents of just under four per cent (UN-Habitat 2017; Schmidt *et al.* 2018). Private and public real estate investments have produced a veritable construction boom across much of the city, translating into a significant rise in some but not all financial resources available to the AACA. The city administration's total revenues rose from ETB 7,067 million (around US$ 416 million) in 2011 to ETB 21,761 million (around US$ 1,053 million) in 2015, in current numbers. These revenues comprise funding from five major 'buckets': income and profit taxes (which represent the largest share of the city administration's revenue); revenues from non-taxes (e.g., land lease fees); municipality revenues (local taxes, rents, service charges, and the sale of goods and city services); external assistance; and external loans (UN-Habitat 2017). Outside the income and profit tax, Goodfellow (2015) shows the most substantial increase in collected revenues has been from land lease auctions since 2012. Indeed, in the four years leading up to 2015, *non-tax* revenues (which are entirely derived from urban land lease income) rose by 125 per cent (UN-Habitat 2017: 28). This follows from a peculiar combination of policy reforms. On the one hand, Ethiopia has liberalised; national regulations outline new possibilities for international investments and the AACA introduced a fully market-based logic to its land lease auctions. At the same time, the AACA has tightened regulation around how quickly developers must complete real estate projects in order to legally sell them (Goodfellow 2017).

On the contrary, Addis Ababa's municipality revenues, including the 'roof' tax (in effect, a non-market-based nominal form of property tax), rental income on land and city properties, service charges, and the sale of goods and city services, together rose the slowest, by only 78 per cent in volume between 2011 and 2015 (UN-Habitat 2017: 30). Indeed, as highlighted in the graph below, municipality revenues as a percentage of total city administration revenues fell by almost half between 2010 and 2015.

[5] Source of population and land statistics on Bole sub-city is the City of Addis Ababa website: http://www.addisababa.gov.et/fi/web/guest/bole-sub-city

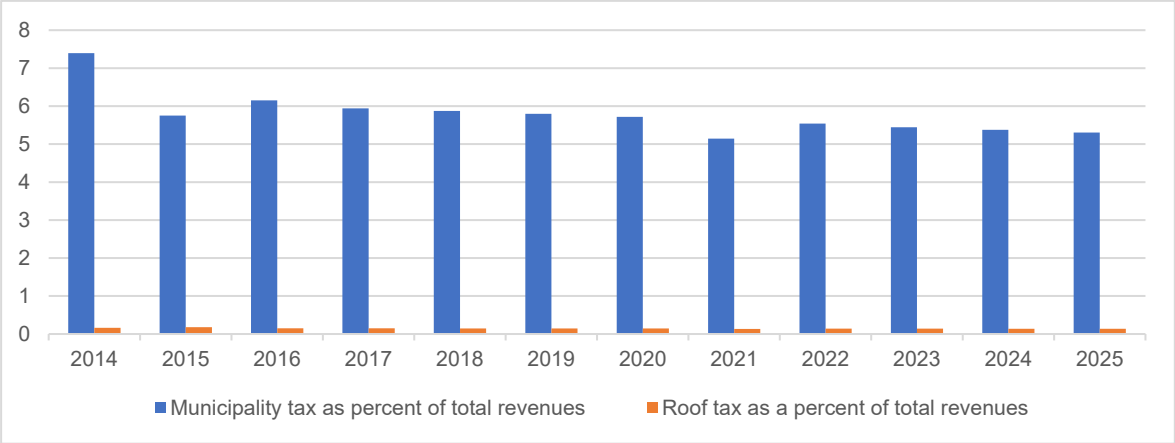
Graph 1 Municipality revenue as a percentage of total city administration revenue (2011-2015)



Sources: Percentages calculated by authors based on data cited in Addis Ababa City Planning Project Office (AACPPO) 2017 and UN-Habitat 2017.

Even within this limited and relatively decreasing pool, the roof tax is impressively *unsubstantial*. In 2016/2017, for example, of the approximately ETB 580 million (around US$ 25 million) municipal revenues collected in Addis Ababa, only ETB 889,187 (around US$ 38,500) – or 0.15 per cent – was from the roof tax (Gelaye 2018a: 10). Instead, it is the sale of goods and city services which make the largest contribution to the portfolio of municipal revenues, typically representing about 55 per cent of this pool (UN-Habitat 2017: 30). A draft summary of the Addis Ababa Structural Plan does not envision much of a shift in this distribution. Graph 2 below depicts the City Planning Project Office's forecast of the portion of total city administration revenues from municipality revenues, as well as from the roof tax collection for the period of 2016 through 2025, based on collected figures from 2014 and estimates from 2015. As shown, authorities do not anticipate that roof tax collection will rise above contributing even one per cent to the city's total revenues.

Graph 2 Forecasted municipality revenues and roof tax revenues as proportions of the total revenue (2016-2025)



Source: AACPPO 2017.

A focus on these figures alone, however, belies the complexity of work involved to improve municipality revenues – and in particular, property tax-like systems such as the roof tax – in Addis Ababa. The AACA's recent history of reform demonstrates that there the organisational obstacles typically found in the roll-out of fiscal reforms – namely capacity and legal authority – are not the major challenge. The AACA has the capacities to conduct and record mass appraisals and to build up the required administrative practices, and it has the legal authority to work toward change. The obstacles which remain appear inherently political – namely resistance from local authorities to implementing politically sensitive reforms and

their expectation of resistance from residents. Goodfellow (2015), for example, highlights how administrative reforms in land leasing systems are crowding out the potential of reforms on property tax in Addis Ababa, as when the AACA introduced full market-based auctions for land leases it also promised not to increase taxes on property. As such, pushing ahead with yet another effort at reform by the AACA could create political vulnerabilities such as those witnessed in its earlier attempt at property tax modernisation.

If reclaiming collection duties, the AACA will thus need to attend to the expectations of political resistance from residents. In the next section, a strategy is proposed by which the AACA could begin to strengthen the trust of residents, namely through the establishment of a clear linkage between property taxes (in Addis Ababa, roof taxes) paid and public infrastructure services received or planned. As Bird and Slack (2014: 364–365) argue, since infrastructure services are typically '"area-specific", in the sense of being most accessible to those [residing] nearby", then the property tax is an appropriate means of raising funds for such benefits. We suggest that in order to make explicit for residents the connection between taxes paid and expenditures toward benefits made, the AACA could support a delicate roll-out of an experiment in roof tax and infrastructure-related collections. Toward that end, we suggest beginning with the local determination of an administrative zone where there is relatively less socio-economic vulnerability and a relatively high degree of extant or planned urban infrastructure services and an active formal real estate market. Our study proceeded through two major phases to determine the precise location of such a highly-serviced administrative zone: the first was concerned with data collection and visualisation, and the second centred on propositional visualisations of a typology of administrative zones through the use of a spatialised composite index comprising key data on characteristics of the local built environment and real estate markets in Addis Ababa.

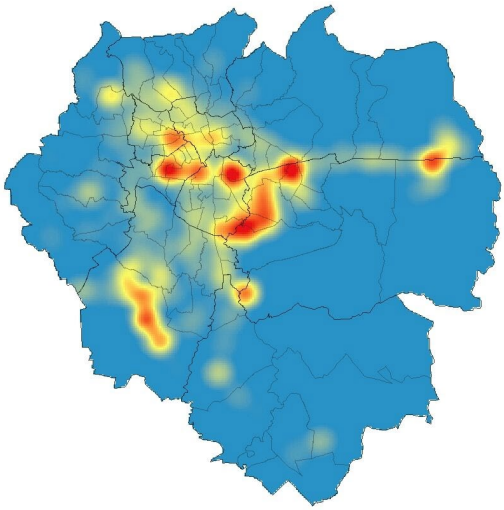
2.1 A focus on Bole sub-city

In the first phase of data gathering, we studied the construction permits issued by the AACA over the past two decades for which we were able to gain information. We found that during the period between 2002 and 2010, the AACA issued 6,095 construction permits; Bole sub-city dominated among other sub-cities as the host of 2,350 construction permits, or 39 per cent of this total. In addition, between 2015 and 2018, the AACA issued another 2,238 construction permits, of which 31 per cent were again located in Bole. Construction permits issued for Bole sub-city were largely for housing (55 per cent) and mixed-use (27 per cent). We also gathered data to identify activity in (formal) real estate markets by studying current real estate brokerage permits by sub-city. We found that out of the 355 unique tax identification numbers assigned to real estate brokers currently active in Addis Ababa, 107, or roughly 30 per cent, operate in Bole.

In comparing satellite imagery of Addis Ababa from 2010 and 2017, we identified 1,445 new buildings with more than three floors, or high-rise buildings, as well as 1,883 new single-family homes. We then extracted their GPS coordinates for mapping and imported this data into ArcGIS software as point data.[6] The largest percentage of high-rise buildings by sub-city (24 per cent) was identified in Bole sub-city. Map 1 below depicts a heat map of new construction in Addis Ababa overall, highlighting areas where new high-rise buildings were clustered between 2010 and 2017, while Map 2 depicts the same for Bole.

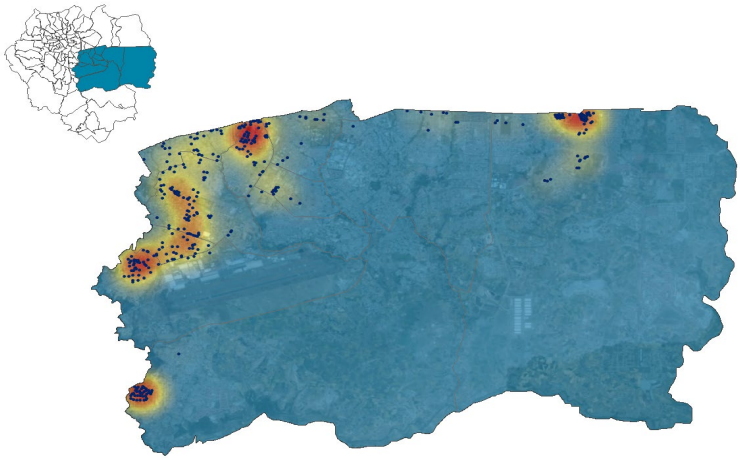
[6] ArcGIS is a geographic information system for working with maps and geographic information and is maintained by Esri.

Map 1 Kernel density of newly constructed high-rise buildings in Addis Ababa



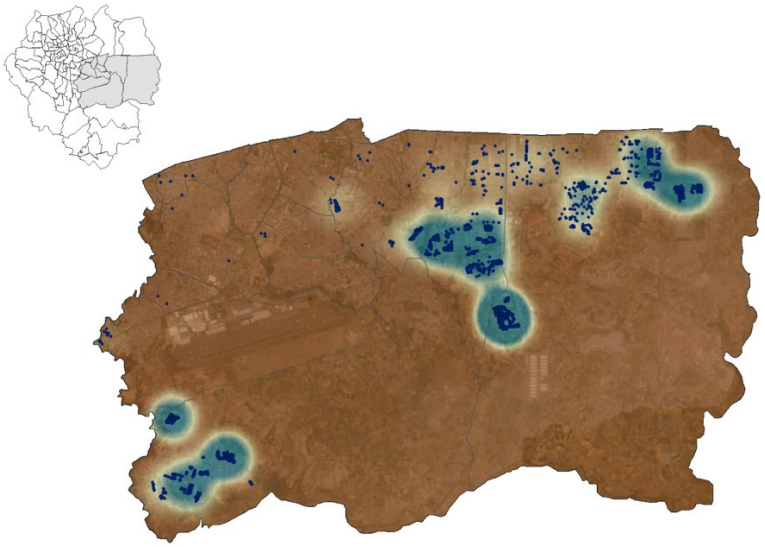
Within Bole sub-city, different neighbourhoods or areas experienced the densest clustering of new high-rise construction versus single-family home construction in the period studied. For example, Map 2 below shows significant high-rise construction in the region just north of Bole International Airport (in Bole neighbourhood – one part of Bole sub-city – and in Bole Medhanialem), while Map 3 shows that of the 1,883 new single-family homes identified between 2010 and 2017, the Goro area in the centre of Bole sub-city experienced the most considerable clustering.[7]

Map 2 Kernel density of newly constructed high-rise buildings in Bole sub-city



[7] The Flintstone Homes, a high-end relatively new development of single-family homes, is adjacent to this area.

Map 3 Kernel density of newly constructed single-family homes in Bole sub-city



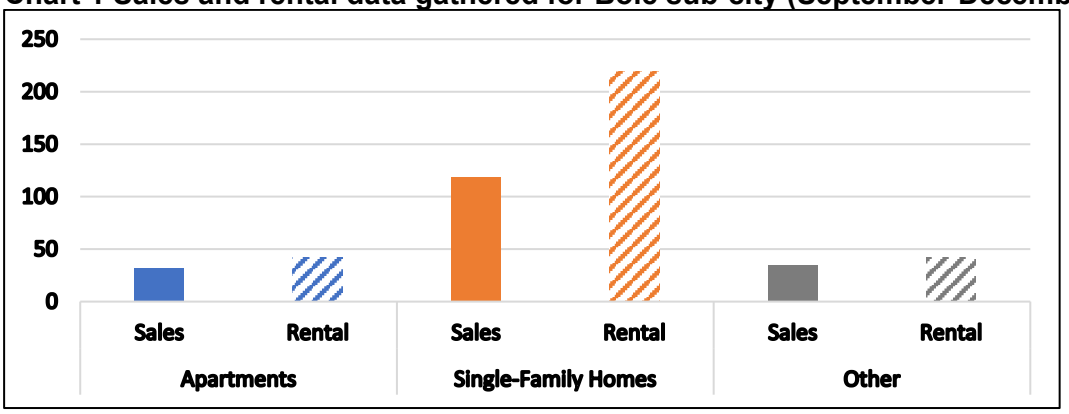
In order to further understand real estate market trends within Addis Ababa by neighbourhood or area within Bole sub-city, we next gathered rental and sales data for homes in Bole to understand and then visualise on a map the extant market rates for different home typologies, including two-bedroom and three-bedroom apartments, as well as single-family homes. We concentrated on privately rented or sold formal homes targeting higher-income households, as opposed to lower-end homes, informal and *kebele*[8] housing, or condominiums. This is because we wished to demonstrate how to connect property tax collection with payments for existing basic infrastructures, thus we concentrated on housing we knew was most likely to have access to basic services. Further, we presume that the AACA already has access to the locations and pertinent price data from condominiums and other government-owned properties generally.[9]

Three major online sources of potential rental and sales data were harnessed for information on apartments and single-family homes, including realty brokerage listings from betoch.com, and realethio.com, and listings uploaded by multiple sources onto Facebook's Addis Ababa platform. In a three-month period (September-December 2018), we found 859 separate real estate listings online for Addis Ababa, of which 489 (57 per cent) were located in Bole sub-city. Among the online realty listings for Bole sub-city, rental properties dominated (see Chart 1 below). The majority were single-family home rental properties, with two- and three-bedroom apartments and other (mostly commercial) spaces making up the remaining listings.

8 Kebele housing is government-owned housing introduced in the smallest scale of administrative municipal divisions during the communist regime (or Derg) in Ethiopia. Kebele houses today are characterised as poor-quality homes with little to no infrastructure or services.

9 Previous studies in Latin America also show that piloting an increase in fees for infrastructure services in higher-end neighbourhoods first can help build the case for the wider public to accept the rolling out of fee increases for basic service improvements (Carolini, Gallagher and Cruxen 2018).

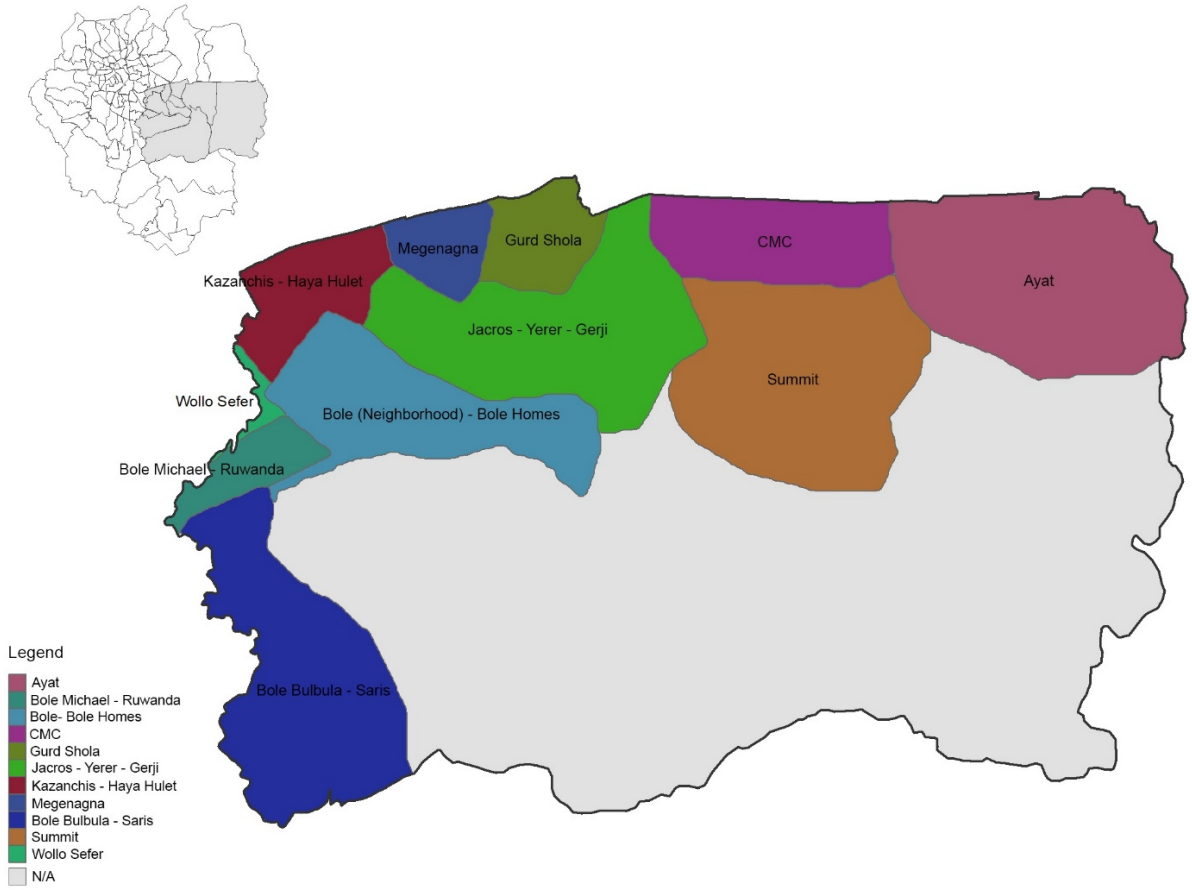
Chart 1 Sales and rental data gathered for Bole sub-city (September-December 2018)



Sources: Online realty listings from betoch.com, realethio.com, and Facebook.com.

We then aggregated Bole sub-city neighbourhoods mentioned in online realty listings into 11 'real estate neighbourhoods' (see Map 4 below) based on their proximity to one another in order to begin the approximation of a typology of administrative property tax collection zones depicting construction and infrastructure availability.[10]

Map 4 Depiction of aggregated 'neighbourhoods' identified in real estate listings



Source: Authors' calculations.

For each of the 11 real estate neighbourhoods in Bole sub-city, we calculated the range and median rental and sales prices of two- and three-bedroom apartments as well as single-family homes. The results are indicated in charts 2-5 below. In the charts depicting the range

[10] It is also important to note that some portions of Bole sub-city had no price listings and were excluded from this analysis.

of prices, darker shaded areas represent the price point at which a larger number of properties were listed.[11]

Chart 2 Two- and three-bedroom apartment sale prices in Bole sub-city by neighbourhood

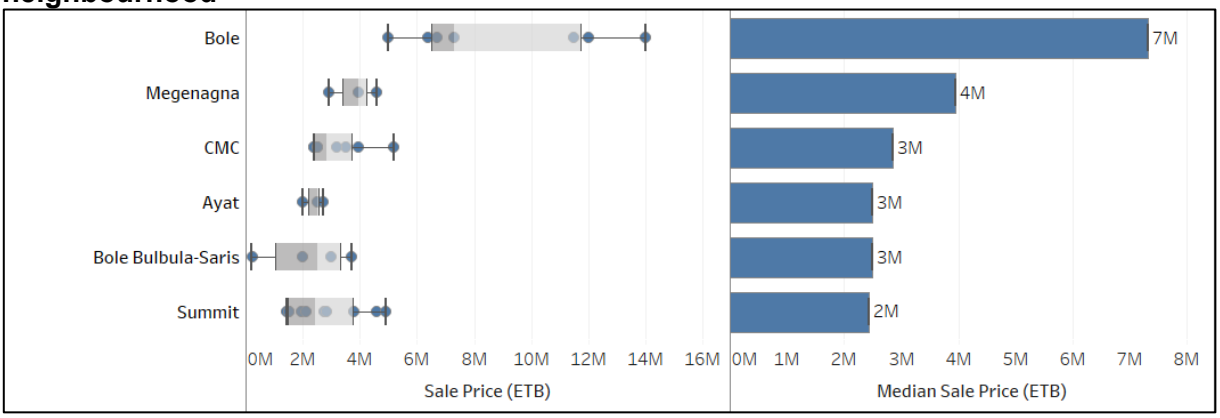


Chart 3 Two- and three-bedroom apartment annual rental costs in Bole sub-city by neighbourhood

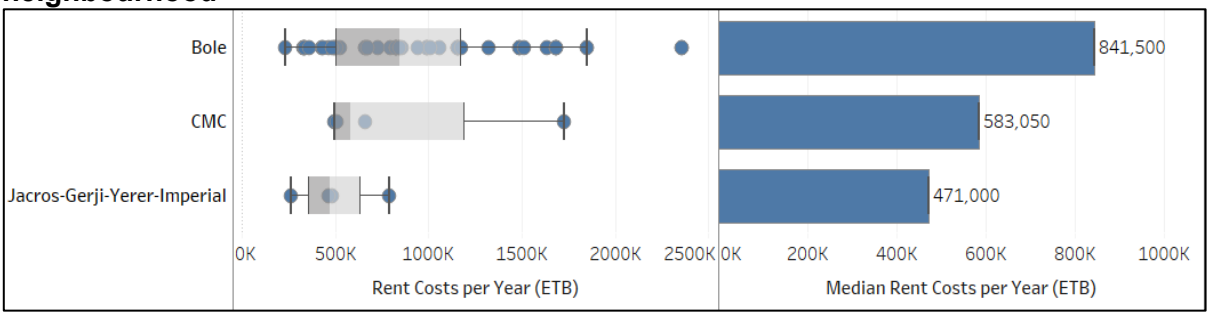
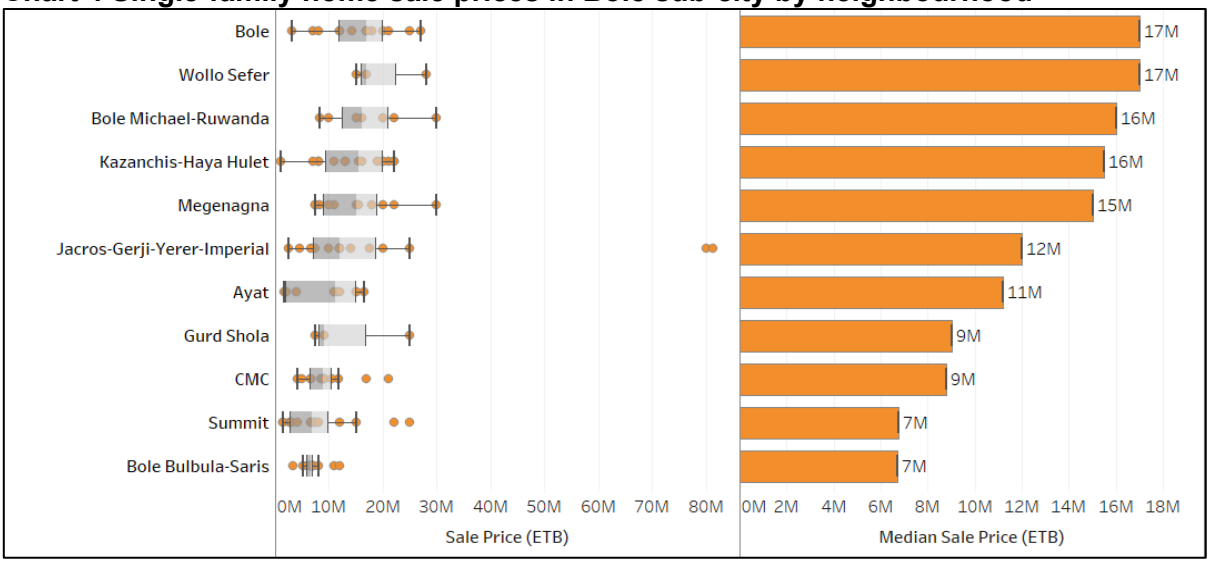
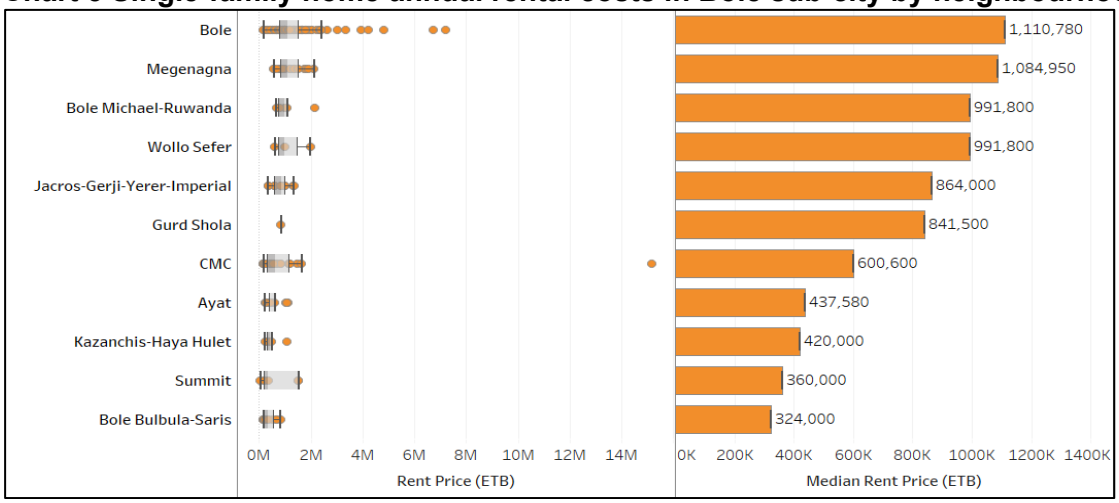


Chart 4 Single-family home sale prices in Bole sub-city by neighbourhood



[11] 'Bole' in charts 2-5 refers to the neighbourhood of Bole within the sub-city of Bole.

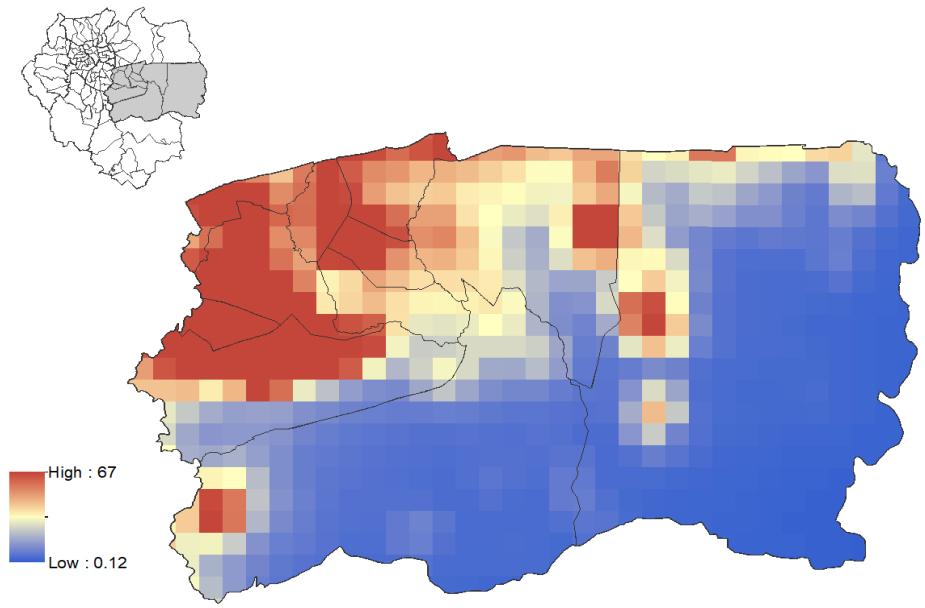
Chart 5 Single-family home annual rental costs in Bole sub-city by neighbourhood



Sources for charts 2-5: Online real estate listings from realethio.com, betoch.com, and Facebook.com, gathered between September-December 2018. NB: Only 'neighbourhoods' with more than one data point are listed for each chart.

Finally, we gathered and visualised data on basic infrastructure systems in Addis Ababa. Night-time light emissions were used as proxy for availability of electricity. The higher the night-time light emissions, the greater the score for this indicator in our visualisation, shown in Map 5 below. These emissions were collected from VIIRS satellite data for the year 2015, the latest year for which data on Addis Ababa was available.

Map 5 Night-time light emissions as a proxy for availability of electricity in Bole sub-city

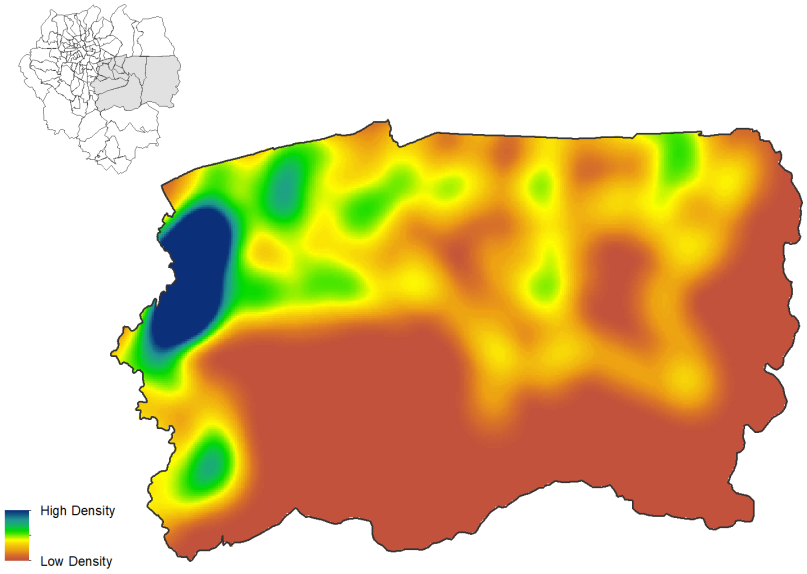


Source: VIIRS satellite data (2015).

Data on existing sewerage lines is based on maps of the sewerage system and plans for its expansion from the Addis Ababa Water and Sewerage Authority's Growth and Transformation Plan (2015). Again, the neighbourhoods just north and east of Bole International Airport appear to be best connected to major sewer lines at present (see Map 6). Secondary sewer lines and laterals also exist in areas proximate to the primary lines, but as primary sewers act as the base for the extended systems, here we concentrated on

visualising neighbourhoods with primary sewerage connections as a proxy for access to treated water and sanitation services.

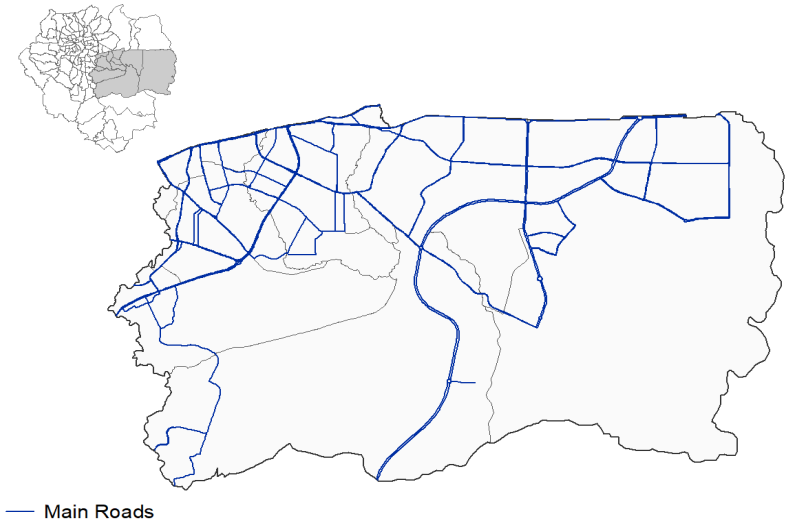
Map 6 Network of primary sewer lines in Bole sub-city



Source: Authors' digitised rendering of existing sewer network map from Addis Ababa Water and Sewerage Authority (AAWSA) (2015).

Finally, we extracted data for Bole sub-city's road network from OSM and included roads labelled as 'primary', 'secondary', or 'tertiary' in Map 7 below.

Map 7 Network of main roads in Bole sub-city



Source: OSM.

2.2 Visualising potentialities of an infrastructure-property tax nexus

In order to identify a typology of collection zones for the phasing in of a combined bill for property/roof tax and infrastructure service fees, we calculated a composite 'infrastructure-property tax nexus' (IPTN) index with spatialised data from three major domains: *housing*

prices, *new construction density* and *infrastructure and services availability.*[12] Within each of the domains there are several indicators. The housing price indicator consists of combining the median rental and median sales prices of apartments and single-family homes. The new construction density domain consists of two indicators: density of new high-rise construction as well as new single-family home construction between 2010 and 2017. The infrastructure and services availability domain is comprised of three indicators: total night-time light emissions (as a proxy for availability of electricity), presence of main roads, and existence of primary sewer lines (as a proxy for the quality of water and sanitation services). All indicators were normalised to represent a score between 0 and 1 (0 being the lowest and 1 being the highest).[13] Indicators were then combined into the domains by calculating the geometric mean of the indicators.[14] The geometric mean is applied so that poor performance on one indicator is not linearly compensated by high achievement in another dimension.[15] The calculated score for each of the three domains was normalised from 0-1 so that all three domains were on the same scale before being aggregated into the final index score.[16] We then divided Bole sub-city into grids of 50 metres squared in size. The composite index calculations were done at the level of the grid cell.[17]

The results of our spatialised composite index – the IPTN index – are represented here below (see Maps 8 and 9), highlighting in red the highest quintile and the highest tercile of our index score – where new real estate development, infrastructure availability, and higher housing prices converge.

12 Ideally, the data here would relate accessibility as well as availability, however we were not able to gather sufficient data on accessibility of services at the spatial level required.

13 Normalisation formula: *X - Xmin / Xmax - Xmin*

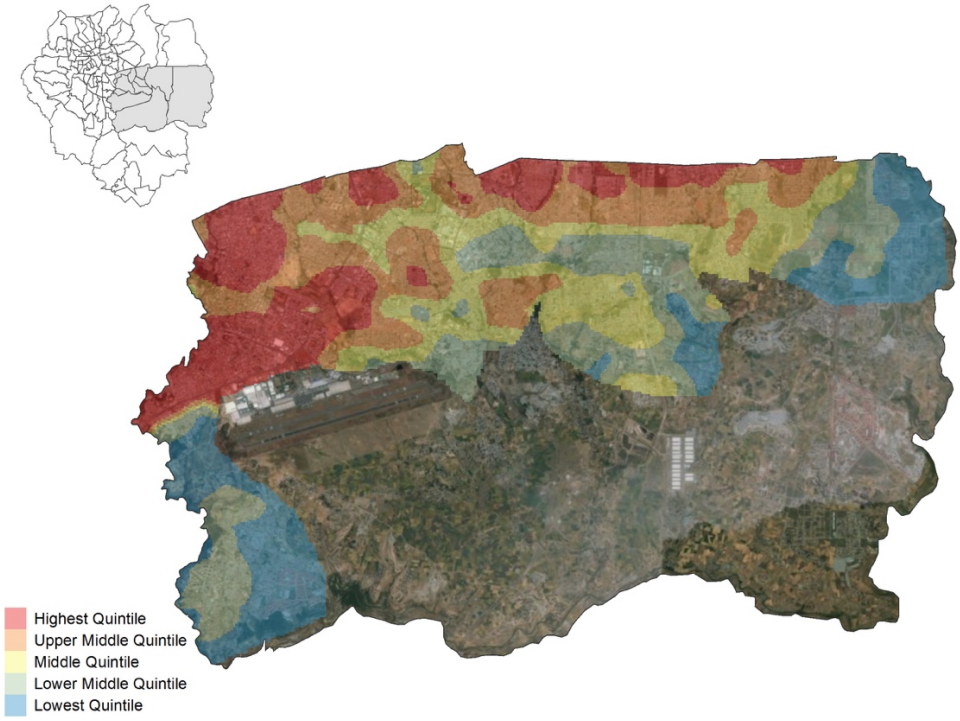
14 Geometric mean formula: *Index score* = $\sqrt[3]{}$ *(Prices data * construction * infrastructure)*

15 For the same reasons, the geometric mean is used in the calculation of the United Nations Human Development Index. See 'Why is the geometric mean used for the HDI rather than the arithmetic mean?', *Human Development Reports*. (n.d.), http://hdr.undp.org/en/content/why-geometric-mean-used-hdi-rather-arithmetic-mean

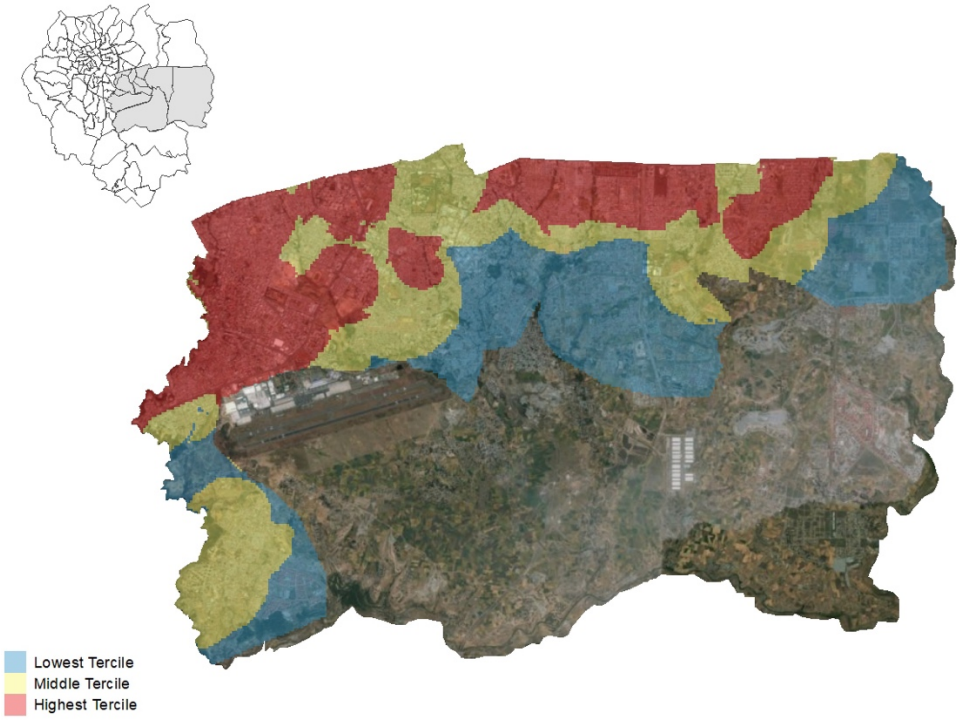
16 It is important to note that a zero value for any one indicator would cause that grid cell to receive a nexus score of zero because the geometric mean includes a multiplication. To avoid this problem, instead of a minimum normalised value of 0, we set the minimum value to 0.001 or the minimum value for indicators with minimums which are beneath this threshold.

17 The lack of highly granular data for the availability of services is a limitation to this approach. Furthermore, neighbourhood names used reflect those in real estate listings and are not official administrative areas. As such, in order to incorporate price data, the general outlines of neighbourhoods were drawn and digitised into ArcGIS software from examining Google Maps.

Map 8 Proposed IPTN index results in quintiles



Map 9 Proposed IPTN index results in terciles



Our spatialised index mapped above indicates that within Bole sub-city, Bole neighbourhood and Bole Medhanialem, just north of Bole International Airport, represent areas of consistently high scoring in a composite considering infrastructure services, new construction density, and formal real estate activity. The potential for piloting an administrative zone for an advanced property tax collection system that synchronises property/roof tax payments with extant infrastructure fees and fees for planned upgrades for infrastructure services could use such a spatialised index to identify high-performing areas such as Bole neighbourhood and

Bole Medhanialem. Alternatively, the index could be useful for identifying up-and-coming zones – perhaps those in the middle (yellow) tercile of Map 9 – where future infrastructure development plans mean that combined billing for property/roof tax and service fees could be introduced moving forward. In the concluding section below, we consider this potentiality of piloting a connection between infrastructure services – such as those in the water and sanitation sector – and the collection of the current roof tax (or a modernised property tax) in Addis Ababa.

3 Conclusion: potentialities and practice

Urban infrastructure development and the enhancement of own-source revenues within municipalities ultimately serve the same policy purpose: to improve local economic and social development. While the amount of research carried out on both these two subjects within African cities has risen independently, their relationship is typically delimited to discussions of how infrastructure is a factor driving property valuation. This should change. Policy connectivity between infrastructure development programming and property taxation systems presents a critical area for greater exploration in research and in practice to improve both systems.

Here we have argued that there is much to gain by deepening the discussion of potential programming linkages between urban infrastructure systems and property taxation – perhaps most critically in the domain of property tax collection. Within Addis Ababa, infrastructure systems are modernising and expanding at a rapid rate. Beyond hosting the first light rail system and waste-to-energy plant in sub-Saharan Africa, Ethiopia's capital also boasts an expansive potable water system. Furthermore, the Addis Ababa Water and Sewerage Authority plans on extending the main lines of its sewerage grid to reach within three metres of all households in the city (Gelaye 2018b). Households within three metres of the main lines will be required to connect to the grid via lateral pipes, and to finance the connection (AAWSA 2015). Even households that are not within proximity to the secondary lines can choose to request connection by going to the authority's head office (Birhane 2017). Along with their request, they must provide documentation that proves the legitimacy of their tenure, a water bill they have recently paid, and they must be able to pay a connection fee, which starts at approximately 3,450 birr (US$ 150) and increases depending on the household's distance from the main line (World Bank 2017). After paying this fee, customers are expected to pay service charges along with their water bill.

With its plans and financing for the upgrading and extension of sewerage lines secured,[18] AAWSA presents itself as a very tangible, potential medium through which Addis Ababa can also improve future property tax (or current roof tax) collection – even before improved valuation. Precedents also exist in the way that several infrastructure fees are already linked in one bill, in Ethiopia as well as elsewhere. For example, solid waste collection fees in Addis Ababa are already paid as a service charge added to residents' water bills. In Mozambique, several cities – including the capital Maputo and others like Matola and Beira – include solid waste collection fees with electricity bills.[19] The arrangement dictates that solid waste collection fees should be proportional to energy usage fees. For example, in Maputo in 2015, a household whose monthly energy consumption sat between 0-200 kilowatts would be charged 45 Meticais (around US$ 1.30) per month for waste collection, while a household

[18] The World Bank is behind a USD 170 million loan for the expansion of Addis Ababa's water and sewerage system. While this funding is formally secured, the project is experiencing delays at the moment due to the lack of equipment and technical capacity required to meet the Bank's conditions.

[19] In Ghana, efforts have been launched to similarly link tax payment (though in the Ghanian case, for income tax) with other State-issued services. The country is introducing individual tax registration numbers that residents will also need to apply for government services like a driver's license or a passport (Dzawu 2018).

consuming 201-500 kilowatts would pay a waste collection fee of 75 Meticais (around US$ 2.16) (Nhanchote 2015). The state electricity company, Electricidade de Moçambique (EDM), typically receives a commission from the collection of fees with its monthly billing and passes on revenues from the waste collection fee to the municipal administration. Indeed, EDM has a similar commission in its collection of fees for the national radio station, Rádio Moçambique. However, while the mechanism itself has worked to collect fees, there is growing frustration among residents who complain that they pay fees for waste services which they have not received, underscoring the importance of ensuring that infrastructure improvements are tangible when connected to the collection of other related fees and taxes. For these reasons, the proposed IPTN index presented in this paper provides a spatialised typology demarcating areas that are prime candidates for intervention (i.e., where the composite score is highest, in red) and areas where infrastructure services are not advanced, and thus should not yet entertain the combination of billing for infrastructure service fees and property/roof taxes.

While resistance to experiments in property tax collection through infrastructure-related billing may be expected, there are compelling reasons to consider it in areas where the real estate market is booming, and where some – but perhaps not all – basic services are well in place. Using Bole sub-city as a take-off point, our spatial composite index allows practitioners to customise and ascertain which parameters should weigh most heavily in identifying zones for the combined collection of property (or roof) tax and infrastructure-related fees in Addis Ababa. While this paper proposes focusing on areas earning the highest marks across extant infrastructure, housing prices, and new construction density, municipal authorities interested in rationalising the demarcation of different zones for experimental tax collection could instead choose to elevate the importance of not extant but *planned* infrastructure systems to identify zones where funding for new infrastructure services via a mechanism akin to special assessment fees could be coupled with roof tax collection. In short, this paper aims to inspire rather than prescribe an approach to both identifying practical steps and to harnessing data tools by which infrastructure development and property tax administration can be better adjoined in practice.

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