Final report

Housing need in Kigali

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Final report

Housing need in Kigali

Jonathan Bower

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With contributions from Robert Buckley and Laura Wainer

Abstract

This paper estimates i) the quantity of housing needed in Kigali, Rwanda; and ii) the purchasing power of tenant and mortgage-holding households with respect to housing; and thereby aims to contribute to an understanding of market demand for housing in Kigali, Rwanda. The study estimates that around 373,000 additional households will need to be accommodated in least 310,000 houses, in the period from 2017 to 2032; annually this represents 18,000 new households per year in 2017 rising up to 32,000 during 2032, accommodated in at least 15,000 houses rising up to at least 26,000 new houses in 2032. In addition, in 2017 there was a housing backlog of 137,000 houses, representing about two fifths of the housing stock, that need to be replaced according to criteria provided by the City of Kigali, although we recommend that the criteria for replacement should be carefully revisited. This study then projects income for all income quintiles and estimates the maximum value of property that a tenant household and a mortgage-holding household can afford at the different quintiles. A household at the median of the middle quintile can afford to rent a house worth 10.5 million RWF in 2020 or a mortgage of just 4.1 million RWF at standard terms of 17.3% annual interest and a repayment period of 15 years, if they can afford a 20% down payment. We present a policy discussion on the implications of the findings for meeting rising need for housing efficiently and cost effectively.

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Acknowledgements

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This report was prepared in Kigali by IGC Country Economists Jonathan Bower and Sally Murray, with valued comments and amendments from Professor Robert Buckley and Dr Laura Wainer.

1. Executive Summary

This study aims to contribute to an understanding of the demand for housing in Kigali, Rwanda, updating projections from an EU-funded 2012 study by Planet Consortium, "Housing market demand, housing finance, and housing preferences for the City of Kigali". Using the best data currently available, we attempt to quantify:

i) housing need[1], or in other words, how many new dwelling units will need to be built in the period from 2018 to 2032 to provide housing units of adequate standard to all households in Kigali,
ii) the affordable value of property to rent and to own with a mortgage at prevailing market rates.

Our goal is that the study leads to a better understanding of future housing need and the market-based demand for housing in Kigali. We then discuss policy considerations that flow from the finding that it is likely that the demand for housing cannot be met at what appears to be affordable prices and rents.

The analysis suggests the following:

- **Between 2018 and 2032, the number of households in Kigali is likely to almost double, increasing from around 367,000 households to around 721,000. This respresents an increase of 310,000 houses** from 305,000 to 600,000 houses, assuming that the ratio of households to houses of 1.2 from EICV 5 stays constant to 2032.
- This represents **around 18,000 new households per year in 2018 rising steadily up to around 32,000** in the period up to 2032, **living in 15,000 new houses per year rising to 26,000 in 2032.**
- In addition, if Kigali is to follow the recommendations made by the City of Kigali there will be a need of up to **137,000 new houses to clear the backlog** of housing deemed unsuitable by current standards. However, given that this number represents a high proportion of the current housing stock, almost half, we recommend that careful thought and analysis is given to housing standards that are considered acceptable in Kigali, in order to focus resources on the worst cases.
- The median household in the middle (third) income quintile will be able to **afford to rent a property (house and land) worth a maximum of 10.3 million RWF in 2018** (all prices in this study are in constant 2017 RWF), rising to 12.3 million RWF in 2032; this assumes that the maximum affordable proportion of income that can be spent on rent is 25%.
- The median household in the middle income quintile that can afford a mortgage with a 20 percent down payment **will be able to use a mortgage to afford to own a property** (house and land, if bought outright; cost of constructing house if they own the land) **costing a maximum of 4.0 million RWF in 2018**, rising to 4.8 million in 2032, assuming a 17.3% interest rate and a 15-year mortgage term that is fairly standard for Rwanda.
- The **ratio of the maximum affordable rental property value to the maximum affordable purchased property value is 2.6, assuming a 17.3% interest rate and a 15-year mortgage term**. A 12% interest rate over 20 years, if available, would reduce this ratio to 1.7.
- Using the average rate of increase for Kigali between 2001 and 2015[2] to extrapolate, the **real annual household income for the median household in the third quintile will rise from 2.0 million RWF in 2018 to just 2.4 million RWF in 2032**. Note that this is a real increase in constant 2017 prices, not a nominal increase. The relatively slow rate of growth of 1.3% is caused both by decreasing average household size leading to lower numbers of earners per household, and by

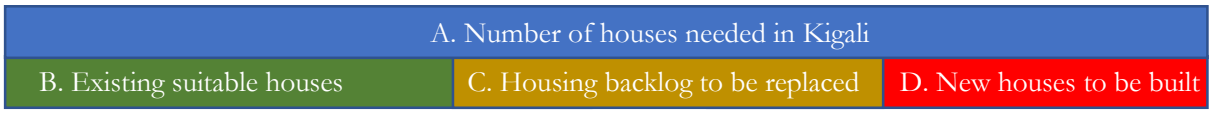
[1] Housing need is sometimes referred to housing demand in this study; however, the following is a helpful distinction: "Housing 'need' is an indicator of existing deficit: the number of households that do not have access to accommodation that meets certain normative standards" whereas "Housing 'demand' is a market driven concept and relates to the type and number of houses that households will choose to occupy based on preference and ability to pay. Heath, S, (2014), "Housing demand and need (England)", Standard Note SN06921, Social Policy Section, Library of the House of Commons.

[2] We used a growth rate of 1.3%, which is the average of real (not nominal) growth in household consumption between EICV 1 and EICV 4 (1.9%), and that between EICV 1 and EICV 5 (0.7%)

migration of poor households into Kigali which puts downward pressure on median household income as more households are added to the lowest income quintiles. This slow growth rate is therefore compatible with much faster rises in per capita income in Kigali.

Approach

With the context and caveats above in mind, we proceed to the analysisa The following diagram illustrates how four important concepts relate to each other, namely the total number of houses needed in Kigali, which can be thought of as comprising the number of existing suitable houses, the quantity of housing backlog to be replaced, and the number of new houses to be built.



It is first necessary to estimate the total number of houses needed to accommodate all households in Kigali, illustrated above as A. However, the subject of interest is the difference between housing need and housing supply. It is thus necessary to find the following two housing supply statistics: i) the number of existing houses that are suitable for habitation – B above – and ii) the quantity of housing backlog that may be best replaced – C above – for instance houses that are in an environmentally risky location, houses that are of poor quality, and overcrowded houses that necessitate the construction of additional housing. The total current housing supply is equal to B plus C. The number of new houses to be built, D, will be calculated by subtracting total housing supply, B plus C, from total housing demand A. The total number of houses that need to be built is equal to C plus D.

All of these numbers change from year to year, thus this study estimates them from the period 2018 to 2032. To find the quantity of housing needed, A, this study conducts the following steps:

- Sub-section 3 i estimates the current and future population of Kigali in the medium and long run
- 3 ii calculates household size, defined as the number of people living in each house, and predicts it by quintile for the period to 2032
- 3 iii divides the total projected population by household size to find the total number of houses needed annually, both marginally and cumulatively
- 3 iv estimates the existing housing supply
- 3 v estimates backlog housing that is overcrowded, of unacceptable build quality, or in an environmentally risky location
- 3 vi incorporates backlog housing and housing needed to bring the household to house ratio to one, into the total number of houses needed to meet population growth.

Also of critical interest is the affordability of these houses for the growing urban population. Therefore, the average income level, as well as the income distribution, among Kigali's population, must be taken into account when estimating the appropriate cost of housing. Section 4 i divides Kigali's population into five quintiles, calculates their median incomes, and predicts these incomes by quintile, by year, up to 2032, assuming 1.3% real income growth. Section 4 ii calculates the maximum property value that households at different income quintiles can afford to rent (expressed in constant 2017 RWF), assuming that they spend the maximum affordable proportion, 20%, of their income, on housing; section 4 iii does the same for house ownership with a mortgage (adjusted for inflation assumed to be 3.5% based on the average for the past nine years) at standard terms available in Rwanda.

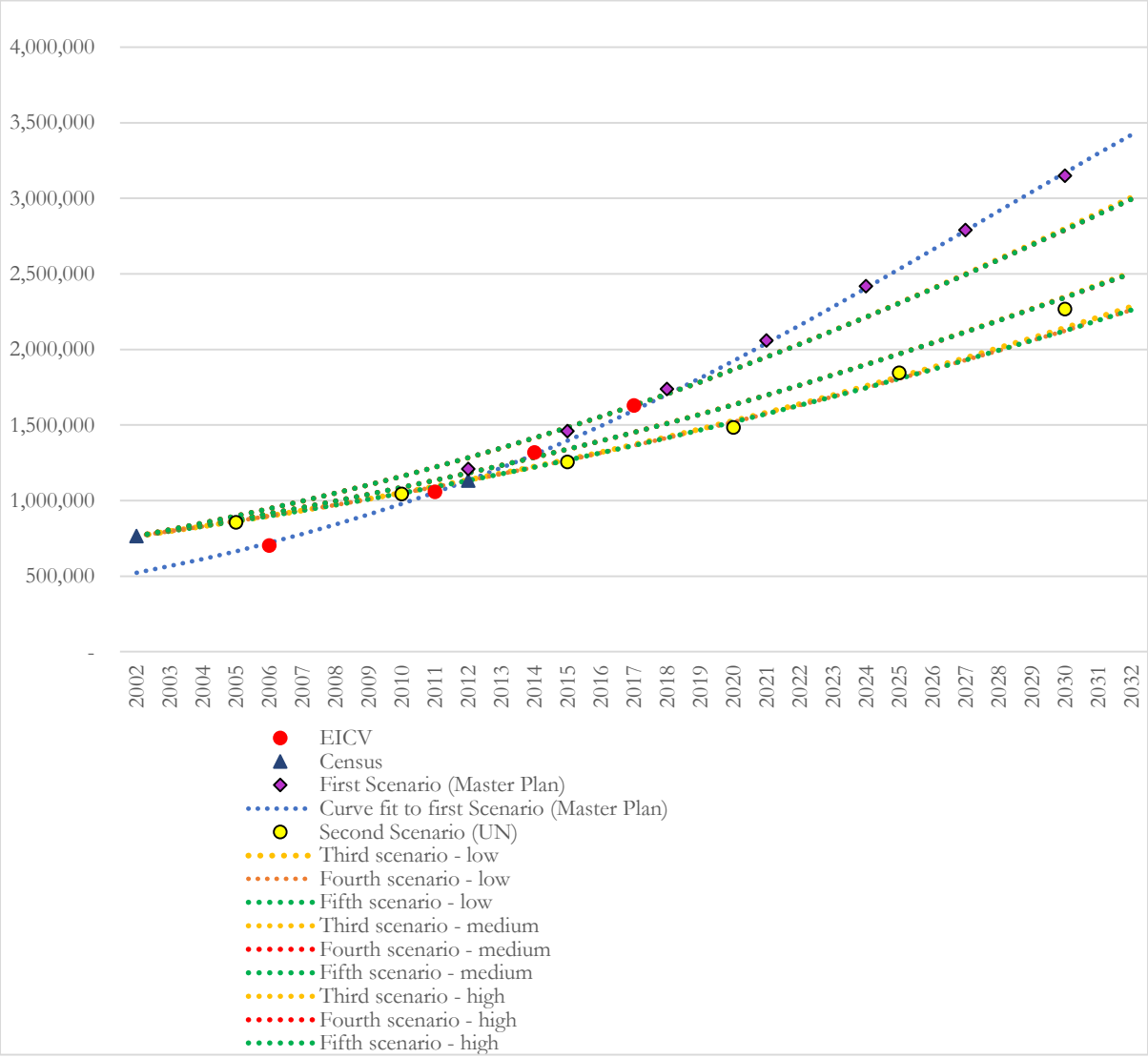
Findings

The findings in this study are summarised by sub-heading below.

Population size: Using the logistic growth curve method, one of the conventional population projection methods, we construct what we consider a moderate population projection for the Province of Kigali. Our

estimate of the population in 2020 is 1.6 million, rising to 2.5 million in 2032. The data points and assumptions behind the population projections are shown in section 3 i and in the spreadsheet accompanying this document. Figure 1 shows the full set of data points and projections, and our various projections.

Figure 1: Kigali population growth scenarios: medium run – 2002 to 2032



Household size: Given two survey estimates we estimate that in 2018 the average household size in Kigali is 4.1. The average household size is predicted, as per regional trends, to reach about 3.5 by 2032, as shown in Figure 2.[3] Given that a household is defined by NISR as people who regularly eat together, rather than merely people who live together, the ratio of households to houses in 2017 was 1.2. Assuming a fixed ratio of 1.2, the average number of people per house is estimated to be 4.9 in 2018 reducing to 4.2 in 2032, as shown in Figure 3.

[3] Calculations shown in section 3 ii and in the spreadsheet accompanying this document

*Figure 2: Mean number of people per **household** 2017-2032 – low, medium and high scenarios*

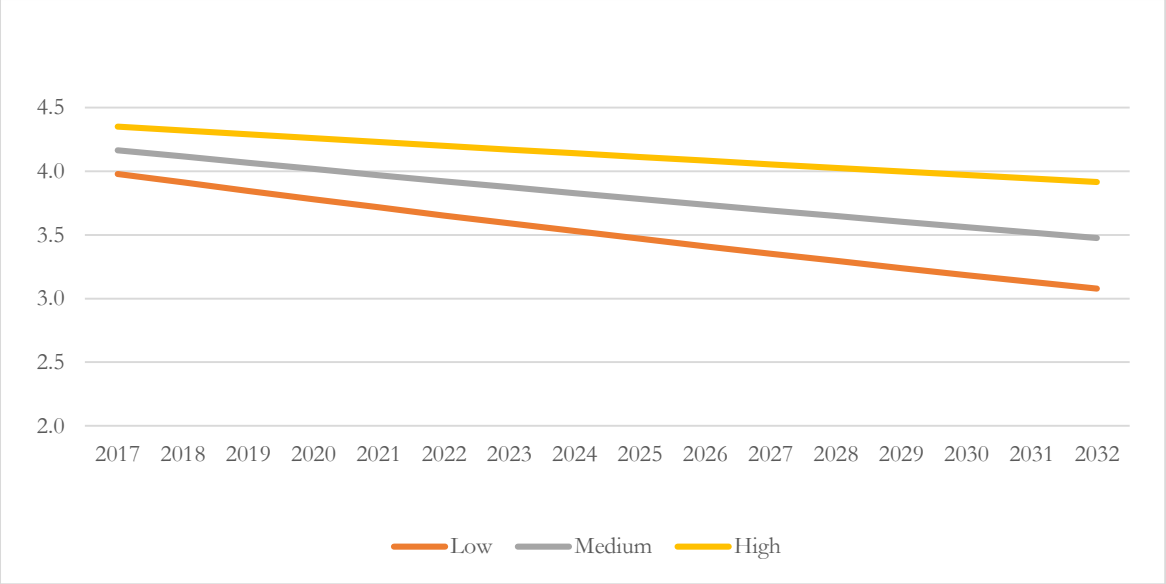
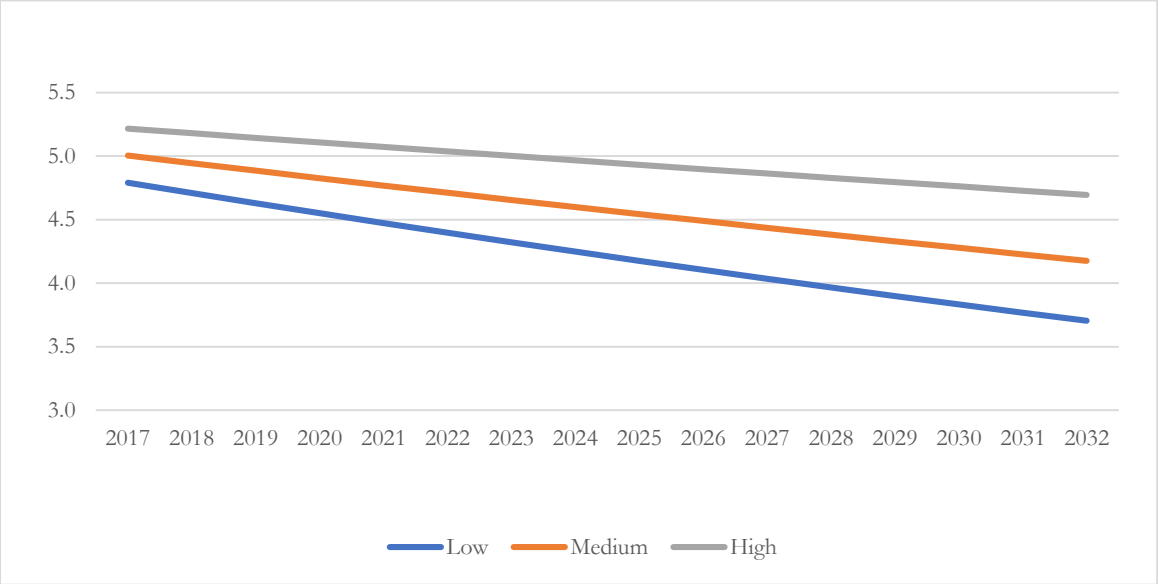


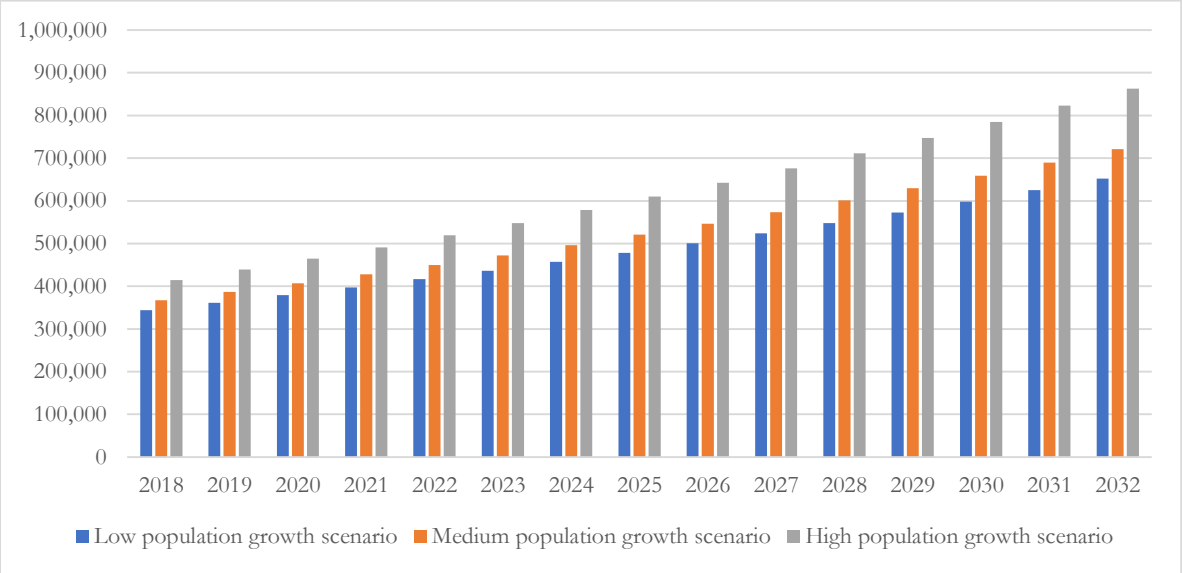
*Figure 3: Mean number of people per **house** 2017-2032 – low, medium and high scenarios*



Projected numbers of households and resulting numbers of houses needed in Kigali: This represents quantity A mentioned in the Approach sub-section above. Under "medium" population growth scenario (shown in Figure 4 below), and a "medium" household size scenario, it is estimated that in 2018 Kigali had 367,078 households which will grow by around 353,958 to a total number of 721,036 households in 2032, nearly doubling in the 14-year period. In the "low population growth scenario", Kigali will grow from 344,301 households in 2018, to 652,414 households, multiplying the number of households by 1.9. In the high population growth scenario, Kigali will grow from 414,507 households in 2018 to 862,703 households in 2032, a multiplication factor of 2.1.[4]

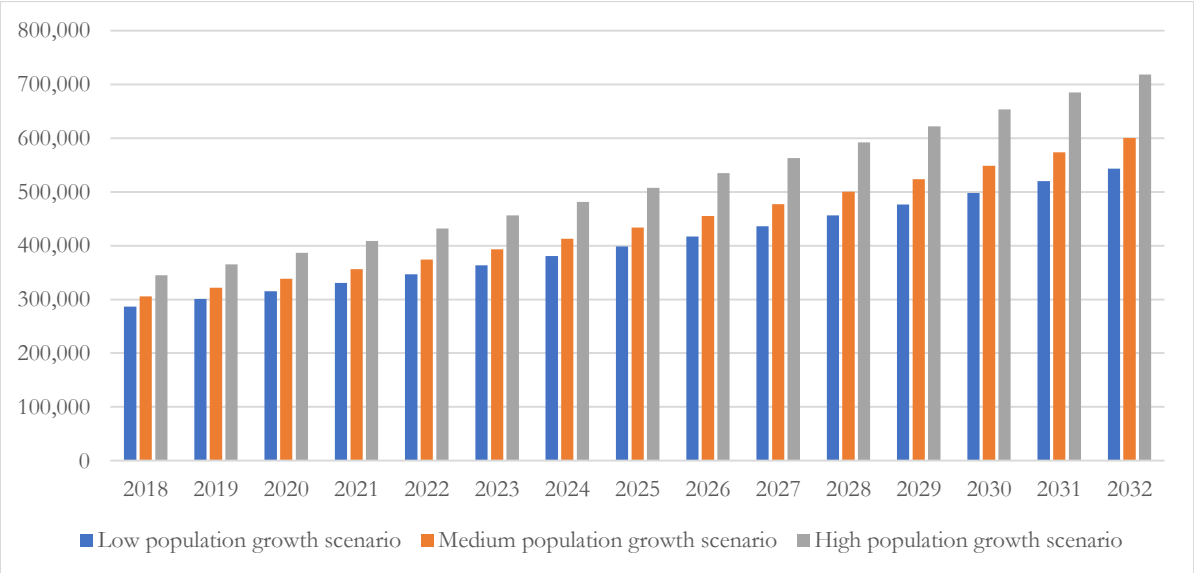
[4] Calculations for these figures are provided in section 3 iii.

Figure 4: Projected total number of households, assuming medium scenario for household size



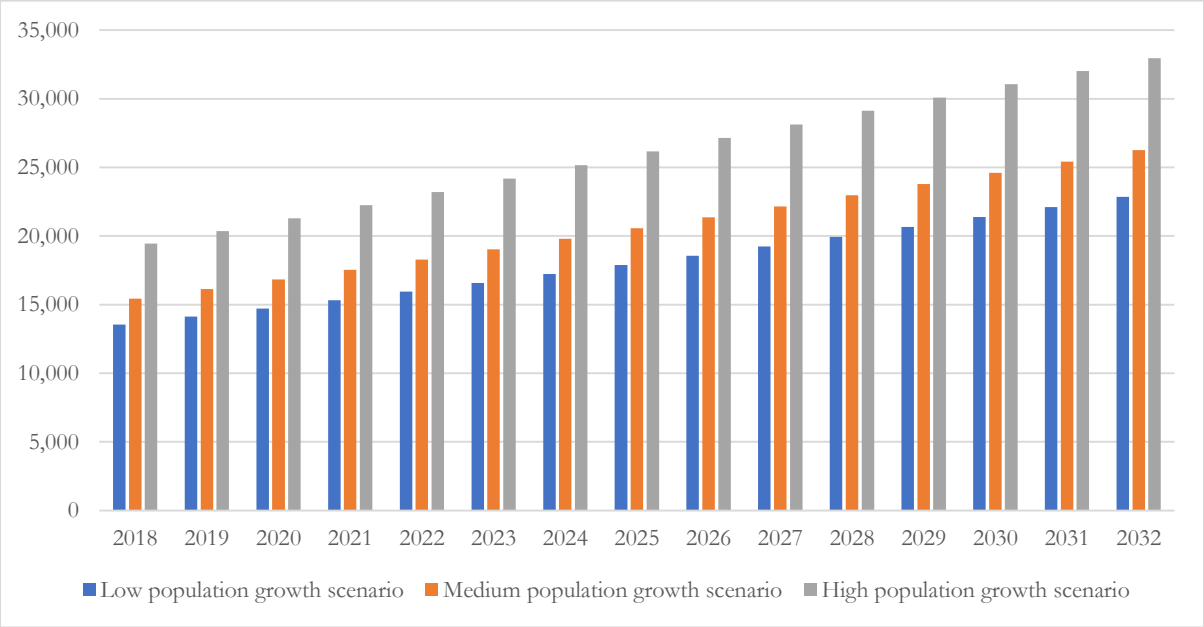
Assuming that the ratio of households to houses of 1.2 in EICV 5 at least does not rise in subsequent years, we can assume the following figures as minimum numbers of houses needed. Under the "medium" population growth scenario (shown in Figure 5 below), and a "medium" household size scenario, it is estimated that in 2018 Kigali needed 305,594 houses which will grow by 294,672 to a total number of 600,266 houses in 2032. In the "low population growth scenario", housing need in Kigali will grow from 286,633 in 2018 to 543,138 in 2032. In the high population growth scenario, housing need will grow from 345,079 in 2018 to 718,205 in 2032.

Figure 5: Projected total number of houses needed, assuming medium scenario for household size



New houses needed per year: The number of new (non-replacement) houses required, representing D in the Approach sub-section, starts at 15,443 in 2018 and rises to 26,259 in 2032, assuming medium population growth, and medium household size scenarios, as shown in Figure 6.

Figure 6: Additional houses needed per year, medium household scenario

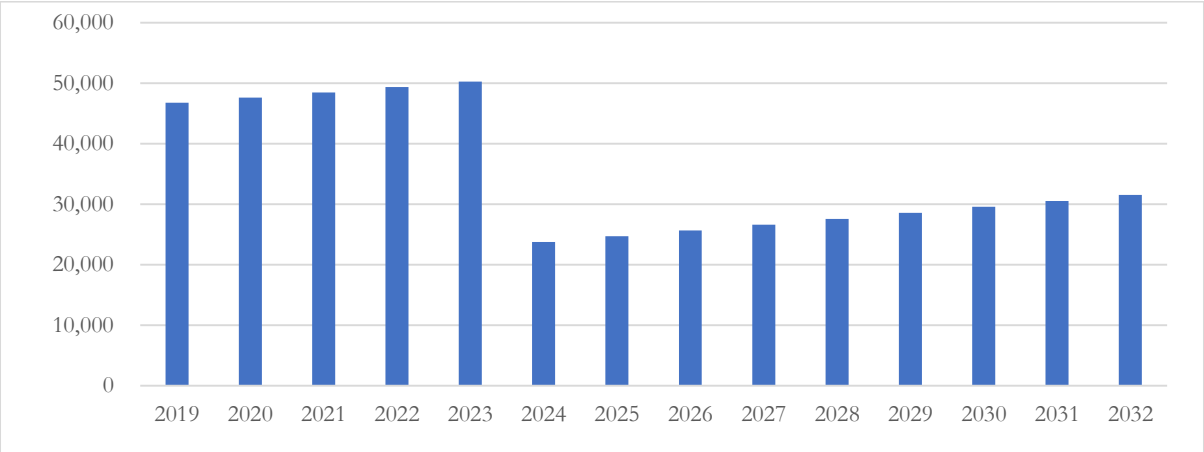


Total current housing supply: This represents a combination of B and C mentioned in the Approach sub-section above and the figures are shown in section 3 iv. We estimate a figure of 290,152 houses in 2017 in the medium population, medium household size scenario, 325,629 houses in the high scenario and 273,077 houses in the low scenario.

Quantity of housing backlog: This number represents C as mentioned in the Approach sub-section above. According to EICV 5, 136,930 houses require replacement; this number represents 40% of the total housing stock estimated in EICV 5. The backlog is made up of the following, clearly overlapping, categories: 54,893 houses are overcrowded, 102,132 are of poor quality, and 13,079 houses are in environmentally risky locations. This is shown in section 3 v.

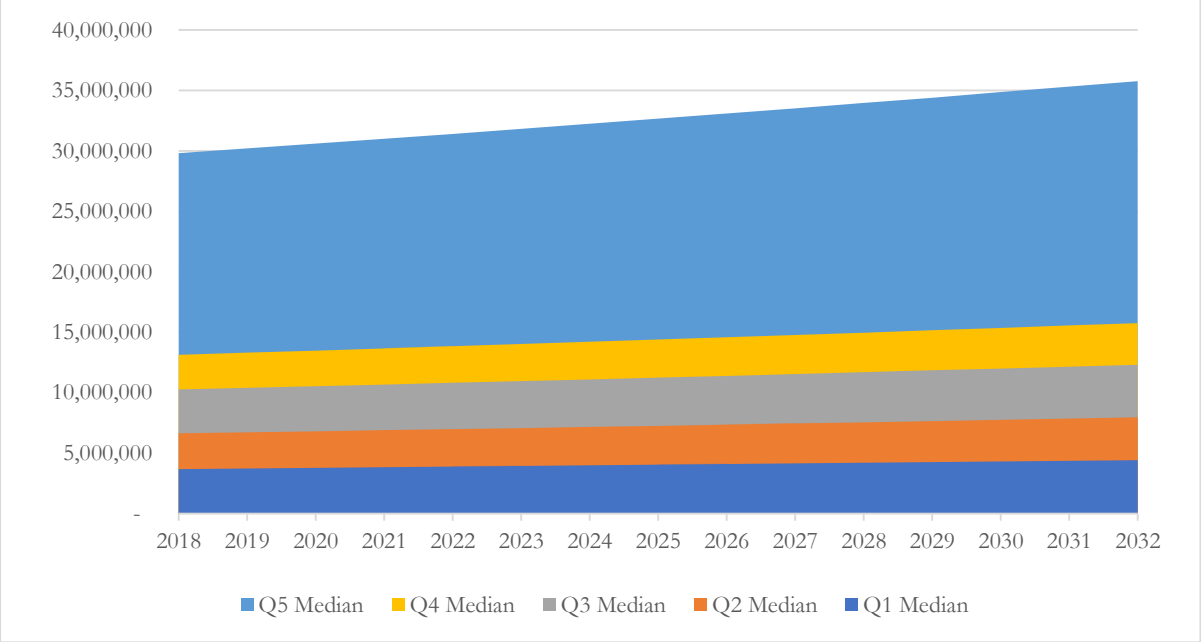
Total houses needed per year: Adding the housing backlog to the number of new houses needed by year shown in Figure 6, and assuming that the complete backlog of 136,930 houses is cleared evenly over the period between 2019 and 2024, Figure 7 shows the numbers of new houses needed, and the scale of the backlog as current acceptable housing definitions would define it. The calculations and tables are in section 3 vi. Clearly the definition and thus the size of the backlog, as well as the assumption about the number of years in which it is cleared, can be changed affording to feasibility.

Figure 7: New houses needed annually to clear backlog, medium household scenario



Housing affordability for tenants: Figure 8 shows estimates of the maximum affordable house price that the bottom three quintiles can afford. Section 4 ii gives calculations for all quintiles; here we focus on the bottom three to illustrate the affordable housing situation. A median household in the third quintile can afford to rent a house that is worth 10.3 million RWF in 2018, rising to 12.3 million RWF in 2032. This assumes that 25% is an affordable percentage of income to spend on rent, and that houses continue to be worth between 22.2 and 16.7 times their annual rental value according to income quintile.

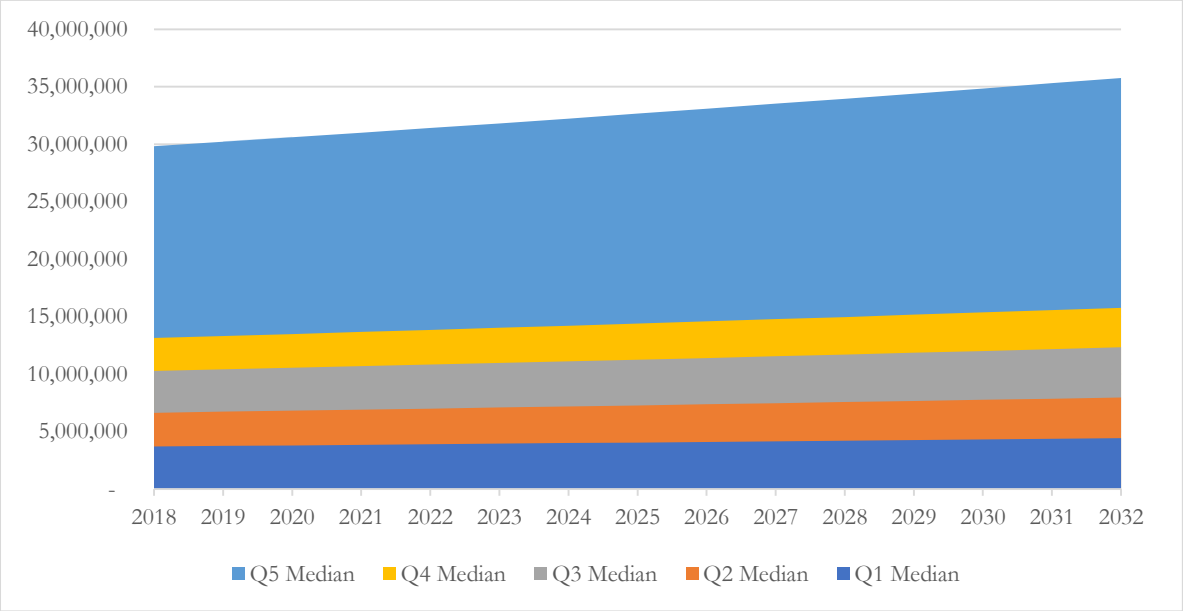
Figure 8. Maximum affordable house values for tenants, (RWF, 2017 constant prices) by household income quintile and by year



Housing affordability for households with a mortgage: In section 4 iii we estimate the maximum value of a property (including house) that a household with a certain level of annual income can afford to buy using a mortgage with terms common in Kigali: a nominal interest rate of 17.3% and a mortgage term of 15 years. We also assume that the maximum affordable monthly mortgage payment for any given household is 25% of income. Although households in the lowest quintiles very rarely access formal mortgages, we include analysis for all quintiles to show the challenge of purchasing power even if housing finance can be extended below the top quintiles. Figure 9 shows that the median household in the middle quintile can afford a mortgage[5] worth 3.2 million RWF in 2018 (in constant 2017 prices), rising to 3.8 million RWF in 2032. This figure does not include a down payment, which is currently likely to be at least 20% of the total mortgage value, representing a barrier to entry into mortgage deals for many households at the median. With the down payment the figure is 4.0 million RWF rising to 4.8 million RWF.

[5] At 17.3%, adjusted for annual inflation projected to be 3.5% based on Rwanda's average for the five years up to 2017.

Figure 9: Maximum affordable mortgage value (RWF) for mid-level scenario of a 17.3% mortgage over 15 years, by median income for all quintiles, without down payment



Our calculations show that there is a consistent ratio of 2.6 between the value of property that can be rented and the value of property that can be mortgaged given a 20% down payment. It is far more affordable to rent at current mortgage terms. A lower, 12% interest rate and a longer, 20-year term would reduce this ratio to 1.7 and would make property ownership affordable for more households.

Policy discussion

Rwanda is urbanising rapidly, from a low level of 17% living in cities according to the 2012 Census. It is clear that in Kigali, housing need and housing demand will increase dramatically in coming years. Satisfying that demand is important not only for the city's functioning and the well-being of the city's citizens, but will have significant implications for the country's economic growth. It follows that the planning steps taken to accommodate this demand through the provision of infrastructure and the regulations that govern housing supply are key policy measures.

The National Housing Policy is a comprehensive document that eloquently recognises the challenges inherent in housing and the kind of approach required. An effective approach to implementing the policy must take account of the most efficient and impactful use of public money, focus on public goods, and respond to an accurate picture of household purchasing power and market forces, to provide an environment in which market conditions facilitate the private sector to turn this need into a demand for decent housing. The exception to this is the direct upgrading and provision of housing to the most vulnerable of Kigali. At the end of this report we present a range of considerations and recommendations aiming broadly at matching supply to demand at lowest cost and at the role the government might play in this. We summarise the points here; each point is elaborated in Section 6.

- Infrastructure will take a large amount of public investment; for cost effectiveness, it should be planned and built before housing, and might include a well-designed "sites and services" pilot
- An incremental approach takes time but is a financially manageable way to upgrade housing
- Public money should be spent on social housing for the most vulnerable, in locations sufficiently close to jobs, but thought should go into choosing evidence-based, innovative and cost-effective ways to enhance social welfare
- Affordable housing should be affordable to households below the top two quintiles

- If possible, the cost of construction should be reduced in ways that can be scaled up in the construction industry in Rwanda
- Master Plan zoning should be flexible and respond to market conditions and should be cognizant of the effects that such plans can have on housing affordability
- Inclusive densification should be pursued
- Housing finance should be made more affordable on a self-sustaining basis
- The definition of housing backlog in this study needs discussion and refinement if it is to lead to upgrading policy
- Policymaking must be data driven
- An Affordable Housing Working Group could be instrumental

2. Context and Caveats

Context

The Kigali Master Plan 2007 and its subsequent additions in 2013 and review in 2018, is intended to be an urban planning process that enables Kigali to grow and function effectively in the face of forecasts that Rwanda's urban population is likely to double in the next fifteen years[6]. In the 2012 Census Kigali constituted 10.8% of the national population, over ten times the population of the second largest urban centre. World Bank estimates from night lights estimated that Kigali constituted around 40% of Rwanda's GDP in 2012[7]; a far higher proportion of firms are headquartered in the city. Given Kigali's dominance, it follows that the management and regulation of Kigali's growth – its urban planning -- will play a large role in national economic growth and performance.

Rwanda has a number of policies in place that relate to housing and its place in urbanisation. Most notably, the National Housing Policy (2015) is a comprehensive document with a laudable vision that "everyone, independent of income, base of subsistence, and location, shall be able to access adequate housing in sustainably planned and developed areas reserved for habitation in Rwanda". The policy describes the following constraints to access to formal housing: low purchasing power, low rate of saving, limited access to finance and high cost of finance, high construction costs, the prevalence of the informal sector and associated poor quality of housing, demand for large housing unit sizes albeit predicted to decline, and the fact that "the currently offered houses are not within the range of [purchasing] power of most Rwandan households".

The National Housing Policy is described as providing a framework which:

- "Enables the private sector to address the demand for housing in terms of quantities and access costs offered to clients
- Supports [purchasing] power among population through promoting saving for housing and pooling of individual resources
- Supports financing models accessible to the full range of residents including low income levels
- Emphasises principles of quality and professionalism in both planning and construction of neighbourhoods and housing

[6] Medium Scenario, Table 17 of National Institute of Statistics Rwanda, (2014), Fourth Population and Housing Census. Thematic Report: Population Projections. National Institute of Statistics Rwanda, Government of Rwanda, Kigali

[7] Bundervoet, Maiyo & Sanghi (2015) Bright Lights, Big Cities: Measuring National and Subnational Economic Growth in Africa from Outer Space, with an Application to Kenya and Rwanda. Policy Research Working Paper 7461, Kenya and Rwanda Country Management Unit, World Bank Group.

- Combines land, land use, urban planning, and housing policy directions in order to achieve the efficient use of land and resources when developing housing" [8]

Whilst the policy does contain a range of policy measures, it does not contain or reference projections of housing need, and the City of Kigali has thus far relied on the European Union-funded study (Planet Consortium 2012) which this paper updates. The policy is generally oriented around facilitating the market and only advocates subsidies in relation to social housing and housing for vulnerable populations.

Government investment in housing so far, most of which comes from Rwanda Social Security Board, has resulted in less affordable housing than was perhaps intended. An extreme case is Phase One of Kigali's Vision City housing project which consists of 504 very high-end residential units, in which 102 billion RWF of Rwanda Social Security Board funding was invested[9]. Other examples costing between around 30 million to 70 million RWF for most households in Kigali include Batsinda II, Rugarama, Ndera, Ziniya, Kanombe and houses built for the Integrated Development Programme model village in Masaka[10] [11]. An earlier project, the Batsinda I project, is a more affordable example. According to our calculations, the median household in Kigali can afford to take out a mortgage of 3.3 million RWF in 2020 at current market mortgage terms (with no down payment), or to rent a house worth 10.5 million. Whilst it will be challenging to bring construction costs of formal housing down to these levels, it is possible to construct dwelling units that are more affordable than those currently being funded.

Since 2015 new such projects have been overseen by a National Affordable Housing Support Approval Committee[12]. As shown, these houses are priced above the incomes of most households as calculated in this report; the numbers are also small; the projects here represent 7,480 units in the face of housing need that will reach 17,000 houses per year in 2020. Innovative partnerships are emerging; for example a Memorandum of Understanding signed in September 2018 between China's Broad Homes Industrial International, Development Bank of Rwanda, Rwanda Social Security Board, and BSMART Technology – a research and design firm – and the International Finance Cooperation (IFC) to spend $200 million on the construction of affordable housing units in Kinyinya, aiming to build 10,000 homes[13] of which 1750 homes in the first phase. According to the New Times, "This is RSSB's attempt to invest in affordable housing as the previous housing project, Vision City, is out of reach for most Rwandans with each unit going for between Rwf105m to Rwf180m."[14]

For both the private sector and the public sector, the projected supply of formal housing is outstripped by projected housing need (number of new households in Kigali), due to the aforementioned constraints listed by the National Housing Policy. According to EICV data, backed up by building footprint data, this continues to have two outcomes: i) lower floor space per occupant – which is leading to some overcrowding

[8] National Urbanisation Policy (2015) MININFRA. Accessed on 10th October 2018 http://www.mininfra.gov.rw/fileadmin/user_upload/Rwanda_National_Urbanization_Policy_2015.pdf

[9]The following references were accessed on 10th October 2018: http://www.mininfra.gov.rw/index.php?id=19&tx_ttnews%5Btt_news%5D=174&cHash=cbeed2c6215f175524f6bc8e62fcef08 https://www.newtimes.co.rw/section/read/215787 http://www.theeastafrican.co.ke/rwanda/Business/RSSB-moves-to-recover-funds-stuck-in-Vision-City-project-/1433224-4392404-9pyy4vz/index.html

[10] Accessed 10th October 2018 http://www.mininfra.gov.rw/index.php?id=19&tx_ttnews%5Btt_news%5D=91&cHash=d753c098e3ccc715b076976007896ba4

[11]Accessed 10th October 2018 http://ktpress.rw/2016/12/inside-rwandas-affordable-housing-explosion/

[12] Official Gazette No 48 Of 30/11/2015, Prime Minister's Instructions N°004/03 Of 13/11/2015 Determining The Conditions And Procedures For Obtaining Government Supportfor Affordable Housing Projects. http://www.rlrc.gov.rw/fileadmin/user_upload/Laws/Laws/RWA%20LAWS%20PUBLISHED%20IN%202015/RWA%202015-%20PMI%20N0%20004-03%20%20%20AFFORDABLE%20HOUSING%20PROJECT-GOVERNMT%20SUPPORT%20CONDITION%20%26%20PROCEDURE%20%20%20-%20OG.%20N0-48%20%20OF%2030%20%20%20NOV.%20-2015.pdf

[13] Accessed 10th October 2018 https://www.newtimes.co.rw/business/new-150m-mortgage-fund-debut-coming-month

[14] Accessed 10th October 2018 https://www.newtimes.co.rw/news/consortium-construct-10000-homes-kigali

but which is not severe yet, in most cases; and ii) the continued growth of unplanned settlements. Unplanned settlements are often referred to as a phenomenon that must be eradicated, and policymakers ask, given regulations that do not permit poor quality housing, why such housing persists. Whilst eradicating slums is a worthy medium to long term goal, and will be met by a combination of rising incomes, cheaper and more accessible housing finance and a more efficient construction sector, in current market circumstances these settlements constitute housing that is of low enough cost to meet demand, and the high ratio of formal housing cost relative to household income, explains their existence. Thus in the meantime it would be more affordable for the government, the private sector and the households, to legitimise these settlements in some way and work to improve them incrementally as government funds and household circumstances allow, rather than enacting policies that work against market forces such as bans or expensive appropriation and redevelopment at very large scale. The trend is positive in terms of the proportion of Kigali's building stock: whilst there was an increase in the absolute number of rudimentary buildings, it is worth noting that the proportion of the total building stock in Kigali that is informal fell from 82.8% in 2009 to 79.6% in 2015 amidst a 27.6% increase in the overall number of buildings[15].

The National Informal Urban Settlement Upgrading Strategy is part of the implementation strategy of the National Housing Policy, targeting upgrading of infrastructure, housing, density and household satisfaction with the process of upgrading.

A loan of 150 million USD is planned between the World Bank and the Government of Rwanda at the time of writing, to set up a Mortgage Financing Company with more affordable interest rates and longer repayment terms. This may be a revolving fund so can be re-used as households make repayments. Given its scale, the possibility remains that it may kick-start a new wave of more affordable housing finance through competitive forces, and by demonstrating the viability of more affordable housing finance.

Caveats

This study estimates need and demand for affordable housing based on a number of plausible parameters around predicted population growth, predicted household size, predicted household income growth by quintile, and other important parameters, which are made explicit at appropriate points in the study. These predictions are also based on the best data available on current measures of population growth, household size and household income, and decisions are made, and specified in the study, where official data sources contradict each other due to methodology.

However, caveats must be offered to the projections presented. Whilst Kigali has grown rapidly so far, it has coped with transport, infrastructure and health challenges that come with urbanisation well compared to its regional neighbours. However, while we do not want to understate the likelihood that the city will indeed face extraordinary demands, before considering the various possible scenarios we first want to make clear how the forecasts can and will be affected by a range of factors whose influence and trends are uncertain but likely to be large. We discuss these factors not to undermine the need to undertake this kind of planning exercise, but rather to emphasize the need for flexibility and responsiveness in the way that Kigali's urban planning is carried out. The factors are outlined in the following sub-sections.

How housing prices will affect population growth: For workers to be able to move to Kigali from other locations requires that they are able to afford to do so; that is, that the increase in housing costs that they face in Kigali is not higher than the increase in pay that their higher productivity jobs afford. If the higher costs exceed the increases in productivity people will not move to the city and the productivity gains will be foregone. In the U.S. it has been estimated that such higher costs have reduced migration by a considerable amount, causing GDP growth to be reduced by one-third (Hseih and Moretti, 2018). Given

[15] Bachofer & Murray (2018), Remote sensing for measuring housing supply in Kigali. International Growth Centre, London. Accessed 10th October 2018 https://www.theigc.org/wp-content/uploads/2018/05/Bachofer-2018-Final-report-rev.pdf

that Kigali accounts for an even larger share of GDP than does any city in the U.S., housing costs in Kigali therefore play an even more important role than is the case in the U.S.

It is difficult to predict how migration to the city will be affected by housing costs, because we simply do not know enough about the determinants of housing costs in Kigali to determine the role played by planning practices or local topography in housing costs. Indeed, it is unlikely that the data needed for measuring such conditions will be available in the near term. The following factors will affect housing prices and thus population growth:

- *Topography:* Hilly or sandy terrain and/or areas that are subject to flooding or with surfaces that do not permit construction cause housing costs to increase. Saiz (2010) finds that "most areas in which housing supply is regarded as inelastic are severely land-constrained by their geography"; therefore, Kigali's hilly topography and high proportion of undevelopable land will have some impact on house prices.
- *Housing regulations:* The high housing costs observed in the U.S. are attributed to the role that planning policies on cost factors such as set-backs, lot size restrictions, building height restrictions, road widths and availability can play in affecting housing costs. During the Kigali Master Plan review 2018, it has been recognised that restrictions on minimum plot sizes, set-backs and other regulations, have increased the cost of formal housing more than necessary, and there is some attempt to address these. Having said this, unlike in the US, the impact of the higher cost of formal housing on migration may largely be mitigated in Kigali by the existence of cheap, albeit sub-standard, accommodation in unplanned settlements, but the extent to which this has been the case, along with the extent to which regulations have increased rent and house prices, is unknown.
- *Transport connectivity:* A World Bank study by Antos et al (2016) shows that the density of built up area in Kigali falls off much sooner than it does in the other African cities for which data is available. Density falls from 100 in the central business district to half that level at 4 kilometers. On average, in the other five cities, a density as low as 50 is not achieved until more than 7 kilometers from the city center. This pattern suggests that for many of those who would come to the city to pursue the opportunities offered there, the costs of commuting are so high that fewer people can exploit the job opportunities offered by the city. Not surprisingly, the study also indicates that the density of Kigali's road network follows a similar pattern: there are far fewer road surfaces beyond the close in portion of the city.
  Policies that improve the connectivity of locations beyond the core of the city can be expected to make more people able to commute to work in ways that make their all-in housing and commuting costs more manageable. That is, investments in greater mobility may be a more effective way to lower housing costs than is making the same expenditures on housing. Important empirical detail matters in making such a determination.
- *National and regional factors:* How does Kigali's productivity-housing cost trade off compare to the opportunities afforded by other cities in the country, and region, now and in the future? Can Rwandans and citizens from neighboring countries easily cross borders to migrate, either legally or illegally, to take advantage of what appear to be better opportunities? How does conflict and/or lack of neighbourliness across borders affect migration patterns? Given these uncertainties it is difficult to say how migration patterns, and Kigali's corresponding growth, will take place.
- *The cost and accessibility of housing finance:* Currently, mortgage interest rates in Rwanda are about 17 percent while the inflation rate fluctuates around 5 percent. This implies that the inflation-adjusted cost of borrowing to buy a home is on the order of 12 percent. That is an extraordinarily high borrowing rate, particularly for long term debt. If, in future, cheaper housing finance is made accessible to a range of households that is far more inclusive in terms of income, housing demand will increase due to the fall in housing costs. This will have some impact on migration rates into the city. However, the extent to which housing finance will become cheaper and more widely accessible is highly uncertain, as is the effect that this will have on housing prices and migration.

Other factors that affect housing demand as well as need: The following factors that affect housing demand, for example different demographic scenarios around life expectancy, as well as behavioural factors such as young adults delaying forming their own household or propensity for people to live alone, are beyond the scope of this study. Moreover, the way that housing demand is affected by choices to buy or

rent, employment rates, growth of household incomes, affordability of rents, confidence in the housing market and confidence in the economy, are not considered.

Urban land area: The increase in migration to the city is unambiguously likely to be large, and the city's footprint is almost certainly likely to grow more rapidly than population growth, as Angel et al (2016) have observed for cities around the world. Angel (2012) states that in Cairo, the urban land footprint increased 16 times from 1938 to 2000, well above the approximately 10 times population increase; Accra saw a 50 percent population increase from 1985 to 2000 compared to a 150 percent increase in urban land area. Especially Kigali's hilly geography, there is considerable uncertainty surrounding the amount of land that a two-fold population increase will use, but it is likely to more than double.

3. Estimating Housing Need for Kigali

i. Population Growth

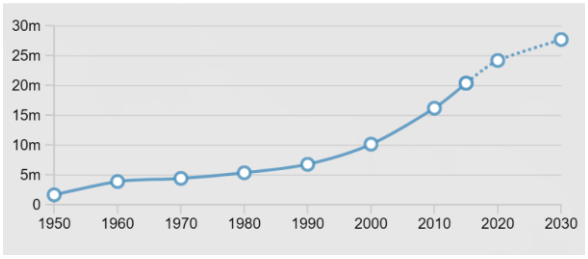
The rapid growth of developing country cities in the past half century (first in Asia, now in Sub-Saharan Africa) has been unprecedented. Whereas established cities in today's developed countries (such as older European cities) may have grown over several centuries, in the past half century some developing-country city populations have increased three- to ten-fold in just thirty years. These city populations typically go through a 'wave' of rapid growth, after which the population stabilises.

One way to capture these city population growth waves is by a 'logistic growth model', which is conventional when modelling populations assumed to have a maximum 'carrying capacity' – the relatively 'stable' population size – for the location in question[16]. The city's population grows rapidly as it first catches the wave of growth, then later slows as this stable population size is approached.

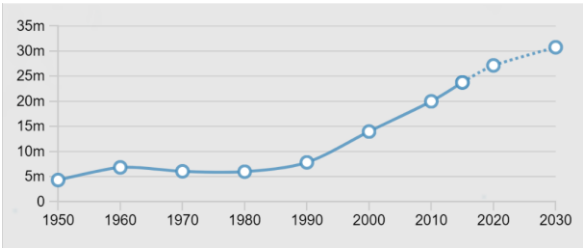
Figure 10: Illustrative population growth in selected global cities, 1950 - 2030 (graph drawn by authors using data from UN Population Projections 2014)

Many Asian cities are stabilising following rapid, dramatic growth spurts

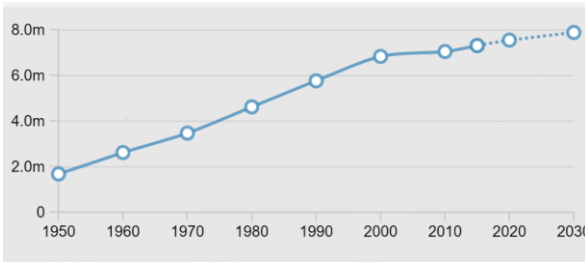
Beijing, China



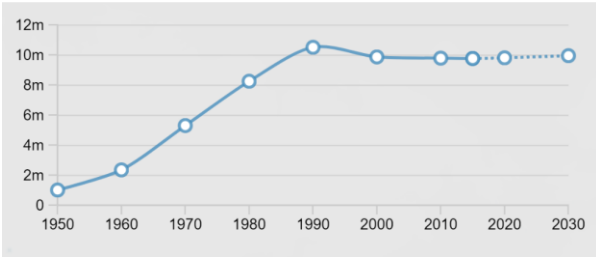
Shanghai, China



Hong Kong, China, Hong Kong SAR

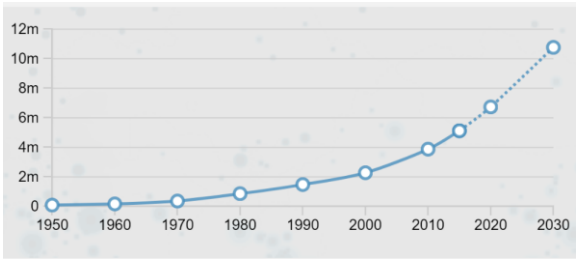


Seoul, South Korea

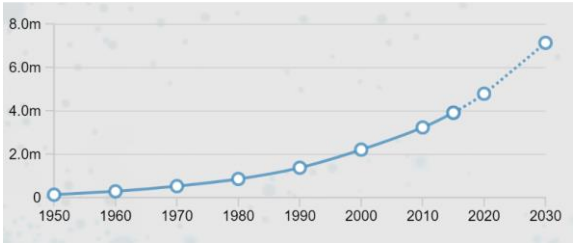


Many East African cities are still riding rapid growth waves

Dar Es Salaam, Tanzania

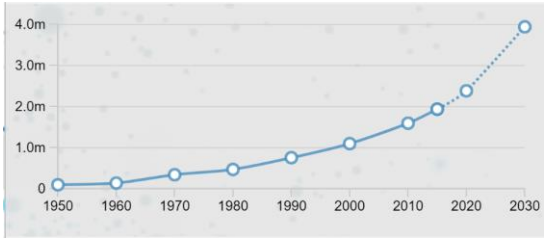


Nairobi, Kenya

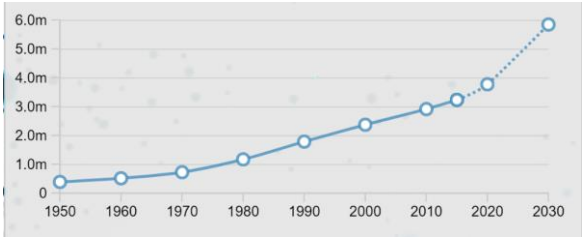


[16] The mathematics of a logistic curve is due to Verhulst, P.-F.: Notice sur la loi que la population poursuit dans son accroissement. Corresp. Math. Phys. 10, 113–121 (1838)

Kampala, Uganda

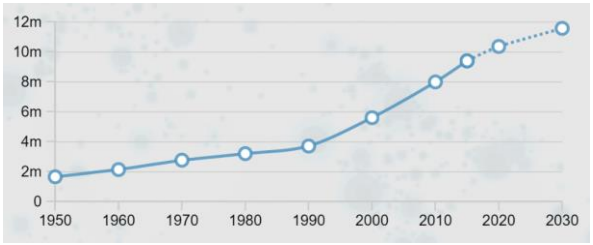


Addis Ababa, Ethiopia

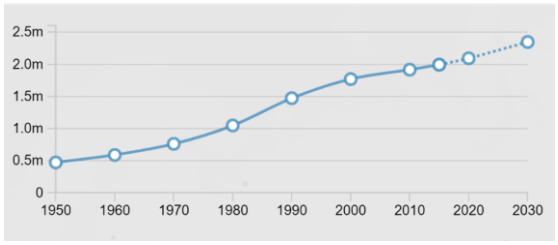


In some more established African cities, growth is stabilising

Johannesburg, South Africa



Tunis, Tunisia



Logistic growth models have their origin in the natural sciences, modelling population trends for species in given habitats: rabbits in a particular forest may double their population every year, for example, until the grass on which they feed becomes scarce due to over-population, leading to a slowing population growth until a stable equilibrium rabbit population is achieved, also referred to as the carrying capacity.

In cities the picture is more complex. City population growth depends not only on deaths and fertility in the city, but also on in- and out-migration from other areas, influenced by the evolving attractiveness of competing rural and urban locations. Whilst it is influenced by geography such as terrain, stable population size for a city is also not based on a maximum capacity set by hard environmental constraints (like grass and land for rabbits), but on policy and investment choices that influence food trade and production, firms' decisions to build upwards, investments to improve water supply, employment opportunities, and so on. Poor rural conditions also drive migration to cities even where provision is inadequate, underscoring that it is not only decisions taken *in the city*, but national policies, investments, and trends, that influence a city's growth. Nonetheless, Figure 10 above shows that the growth paths of many cities follow the kind of "S" pattern described by a logistic growth curve.

In early stages of city growth – when a city is first 'catching the wave' – as in Kigali today, there is particular uncertainty about the size at which the city may stabilise and thus when the growth rate may begin to slow.

City population projections are also vulnerable to inaccuracies or gaps in past data points. In Kigali it is particularly difficult to map a reliable trend in population growth. The boundaries of Kigali were affected by reorganisation of the country's *secteurs* after 2002, and while the 2002 Census population estimates were updated accordingly, population estimates from earlier censuses, EICV 1 and EICV 2 have not been updated. This leaves few reliable data points to study trends in Kigali's population growth – the 2002 and 2012 Censuses, EICV 3, EICV 4 and EICV 5; more consistent and longer-run data is necessary to reliably map a trend. A further challenge is introduced by the fact that the growth rates implied by the EICV surveys is far higher than that implied by the 2002 and 2012 Censuses. Given the inconsistency, it is likely advisable to place greater weight on the Censuses in terms of population size, as these are the basis of sampling for the EICVs. However, it is possible that the EICV estimates are accurate, and population growth has simply accelerated dramatically since the 2002 Census. The challenge of having a few, inconsistent data points, is

confounded in Kigali by the high plausibility of unstable population growth trends in the last three decades, due to the following factors: population loss and migration caused by war and genocide, rapid economic and social development, large shifts in urban and rural policy and investment and declining fertility rates.

Table 1: Kigali population estimates since 1990

Year	Population Estimate	Source	Comments
1991	235,664	Census	Never updated for new boundaries
2001	663,000	EICV 1	Never updated for new boundaries
2002	765,325	Census	As reported in Census 4 publication, due to boundary changes)
2006	703,000	EICV 2	Never updated for new boundaries; unrealistic vs updated 2002 census estimate
2011	1,059,087	EICV 3	Relied on 2002 Census for sampling.
2012	1,132,686	Census	
2014	1,318,590	EICV 4	
2017	1,630,657	EICV 5	

Table 2: Kigali's population growth rate implied by most recent and reliable surveys

Surveys Compared		Years	Implied Annual Population Growth Rate Between Surveys
2002 Census	2012 Census	2002 – 2012	4.00%
2002 Census	EICV 5	2002 - 2017	5.17%
EICV 3	2012 Census	2011 – 2012	6.95%
2012 Census	EICV 4	2012 – 2014	7.89%
EICV 3	EICV 4	2011 – 2014	7.58%
EICV 3	EICV 5	2011 - 2017	7.46%

As shown in the above table, the recent population growth rate for Kigali looks different depending on the surveys considered. The 2002 and 2012 Censuses imply 4% annual population growth, while estimates of growth between the three EICVs imply annual growth above 7%. This is a huge difference.

We now describe five population scenarios using different methodologies, of which four result in similar projections.

First, the least plausible projection is the projection in the Master Plan 2013[17]. The headline Master Plan target population is 4.1 million by 2040. Our view is that it is best not to place much weight on the population projections figures outlined in the Master Plan report, as these were generated even before the figure from the 2012 Census was available, and thus necessarily ignored the lower growth rate between the two Censuses. However, we fit a logistic growth curve through the Master Plan population targets (for model parameters, see Table 5). In this scenario, Kigali's population reaches 1.9 million by 2020 (Figure 11), Kigali's share of the national urban population rises from 65% in 2012 to 75% by 2032 and over 100,000 people come to the city every year in the near term.

[17] The Surbana Jurong team responsible for the Kigali Master Plan is reviewing these projections, which will change during the 2018 Master Plan review

Figure 11: Kigali population scenarios: medium run – 2000 to 2032

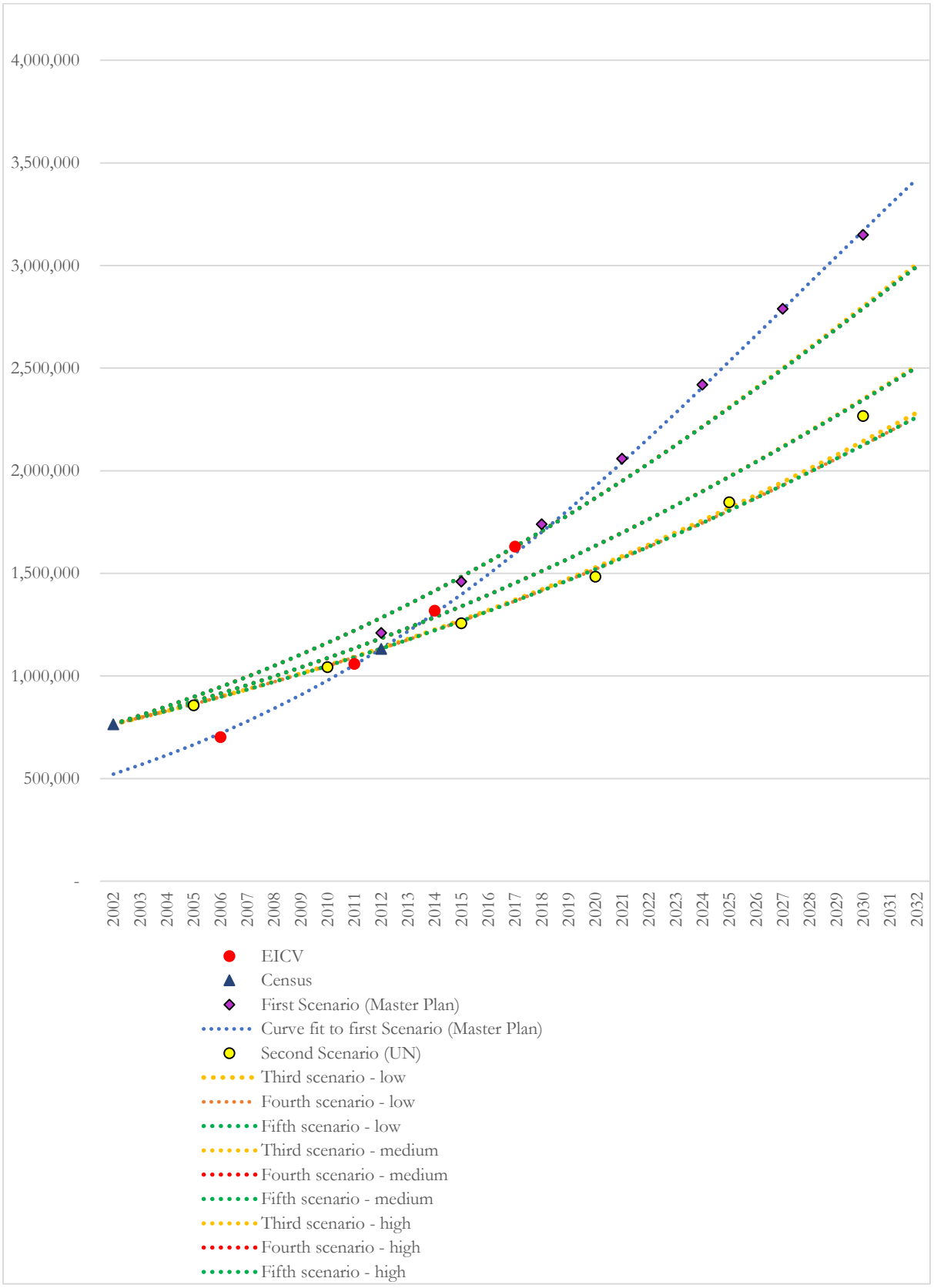
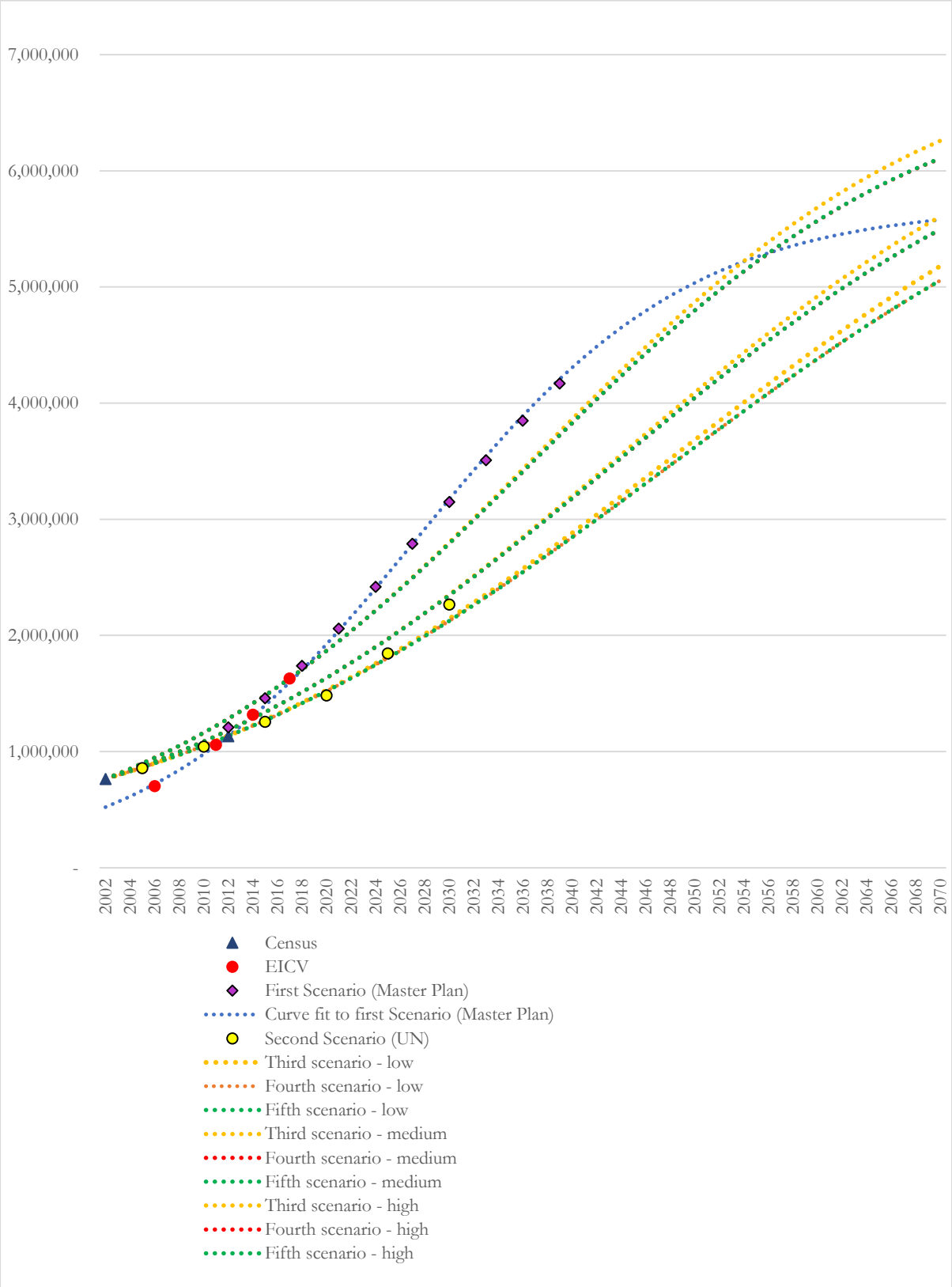


Figure 12: Kigali population scenarios: long run – 2000 to 2070



The second population scenario is comprised of the point estimates visible in Figure 11 and Figure 12, by the UN's 2014 Urban Population Projections, following the methodology used by the UN's Department of Economic and Social Affairs Population Division. This is in line with the Census figures and growth rates, and undercuts the EICV 4 and EICV 5 estimate.

The third, fourth and fifth scenarios are new projections by the authors, based on three different estimates of carrying capacities for Kigali combined with the properties of logistic growth. Within each of these scenarios, we also have low, medium and high scenarios in which we vary the "natural growth rate" as explained in the next paragraph. As mentioned, logistic growth curves consider the population carrying capacity of the location in question. Whilst the concept of carrying capacity is subject to infrastructure investment, geography, consumer preference and other factors, we can begin to estimate this.

When fitting the logistic growth curve, we use the base year as 2002 and run the curve directly through Census population count of 765,325. If we use the 2012 Census count, the curve must run directly through it and not account for the higher EICV estimate, whereas there is no competing datapoint for 2002. Given that the latest Census has a count of 1,132,686 in 2012, and the latest and fifth EICV has an estimate of 1,630,657 in 2017, it is our view that there is no option, whilst using the logistic curve method, but to place the curve between the two estimates. However, we do estimate an upper limit, in which the curve goes no higher than the EICV 5 estimate, and a lower limit, in which the curve runs no lower than the Census 2012 estimate. Given the greater authority of the Census result, given that it is a count for the whole population rather than an estimate from a sample, we place a medium scenario between the Census and EICV estimates, but slightly closer to the Census estimate, weighting this at 66.7%. It turns out that the population projections before 2040 are not very sensitive to carrying capacity if we adjust the natural rate of growth to fit between the Census and EICV 5 result as described. However, it is an interesting exercise to think about and try to calculate the carrying capacity.

Two key factors affecting the carrying capacity of a city are land area and plausible maximum population densities. The Province of Kigali has an area of 730 square kilometres of which just 43% can be developed. The third population scenario is based on an estimate of Kigali's carrying capacity taking into account the high share of land that cannot be built due to slopes and wetlands. We look at population density in ten cities around the world that are generally well established, with a low average growth rate of 1.5%, and that are at low elevation and thus have a very high proportion of developable land, resulting in fairly high densities. These cities are intended to represent the potential density that Kigali's developable areas can sustain. We then multiply this density by the area of Kigali's developable land.

Table 3: Population densities of mature and populous cities at low elevation

City	Elevation (metres above sea level)	Population estimate (thousands)	Area (sq km)	Density (people/sq km)	Growth rate
Barcelona Municipality, Spain	12	1,621	98	16,505	1.1%
Cairo, Egypt	23	9,153	606	15,104	2.1%
Algiers, Algeria	193	2,988	273	10,946	1.6%
Tokyo, Japan	1	9,273	627	14,789	0.7%
Mumbai, India	14	18,395	1,135	16,207	1.1%
Dhaka, Bangladesh	60	6,970	126	55,318	3.6%
Kano, Nigeria	488	3,013	137	21,993	2.2%
Casablanca, Morocco	115	3,360	196	17,142	1.0%
Manila	16	1,780	42	42,384	1.4%
Seoul, South Korea	38	10,125	605	16,735	0.1%
Average	**96**	**6,668**	**385**	**22,712**	**1.5%**

Sources: www.citypopulation.de and World Urbanisation Prospects, 2018.

In each of these ten cities, the land area of each the city corresponds roughly to the built- up area, to speak to a scenario in which the land of the Province of Kigali is fully developed. The average population density

of these cities is 22,712 per square kilometre. Taking into account that just 43% of Kigali's 730 square kilometres can be developed, representing 314 kilometres, and multiplying this by 22,712, the estimated carrying capacity of Kigali is 7.13 million. This figure is plugged into our model, and the other parameters set so that the curve passes through the Census result for 2002, and above the 2012 result, to account for the higher EICV 5 result. Clearly the maximum density of established cities is highly variable and depends on a range of unobserved factors; thus Kigali's developable areas could have a density as low as 15,000, resulting in a carrying capacity of 4.7 million, or as high as 30,000, resulting in a carrying capacity of 9.4 million. Even the higher and lower carrying capacities do not change the population projections to 2040 very much at all, if the curve is fit to pass above the 2012 Census figure and below the 2017 EICV estimate.

The fourth population scenario estimates the carrying capacity a different way. We take the average population density of ten cities that have similar geographical constraints to Kigali, that are at high elevation or have hilly terrain, and multiply it by the *total* area of Kigali, to get another estimate of carrying capacity. The average is 9,391 as shown in Table 4, which multiplied by 730 square kilometres, gives a carrying capacity estimate of 6.9 million.

Table 4: Population densities of populous cities at high elevation or on hilly terrain

City	Elevation (metres above sea level)	Population estimate (thousands)	Area (sq km)	Density (people/sq km)	Growth rate
Addis Ababa, Ethiopia	2,355	3,273	527	6,211	4.4%
Bogota, Colombia	2,640	6,825	380	17,959	2.5%
Guadalajara, Mexico	1,566	1,495	151	9,902	1.6%
Kathmandu, Nepal	1,400	1,003	49	20,289	3.8%
Mexico City (Federal District), Mexico	2,250	8,919	1,485	6,006	0.4%
Nairobi, Kenya	1,795	3,914	695	5,631	3.9%
Sao Paulo, Brazil	760	12,067	1,521	7,934	1.1%
Sana'a City, Yemen	2,250	2,973	400	7,432	3.6%
Srinagar, India	1,585	1,264	243	5,202	2.4%
Puebla, Mexico	2,135	1,498	204	7,345	1.6%
Average	**1,874**	**4,323**	**566**	**9,391**	**2.5%**

Sources: www.citypopulation.de and World Urbanisation Prospects, 2018.

The fifth model uses the densities planned by the Master Plan. Planning for specific densities is a poor guarantee that they will emerge as planned; however, this approach takes account of the fact that the carrying capacity of a city is not independent of policy and depends, for example, on the provision of infrastructure. For example, as services such as roads and water become available, more people will move to a given area, and likewise for power, drainage and other infrastructure. The Kigali Master Plan outlines the government's planned provision of infrastructure for the City of Kigali. As a signal of the 'carrying capacity' the government aims to provide for, we thus integrate its projections into the logistic model.

The Master Plan plans a density of 22,000 in urban areas, which, multiplied by the 314 square kilometres of developable land, represents a carrying capacity of 6.9 million, similar to the fourth projection. This

figure is plugged into our model, and as above, the other parameters set so that the curve passes through the Census result for 2002, and above the 2012 result, to account for the higher EICV 5 result.

Table 5: Parameters of the logistic growth models for low, medium, and high population growth

	Curve fit to first Scenario (Master Plan)	**Third Scenario**	**Fourth Scenario**	**Fifth Scenario**	**Scenarios 3,4,5: % weight on Census 2012 compared to EICV 5**	**Scenarios 3,4,5: % weight on Census 2012 compared to EICV 5**
Max Population	5,700,000	7,131,692	6,905,800	6,908,000		
Natural Growth Rate						
Low		0.0455	0.0454	0.0454	100%	0%
Medium		0.0482	0.0485	0.0485	67%	33%
High	0.09	0.0527	0.0532	0.0532	0%	100%

Note: We did not fit a curve to the UN scenario, because it would have run so close to the third, fourth and fifth scenarios.

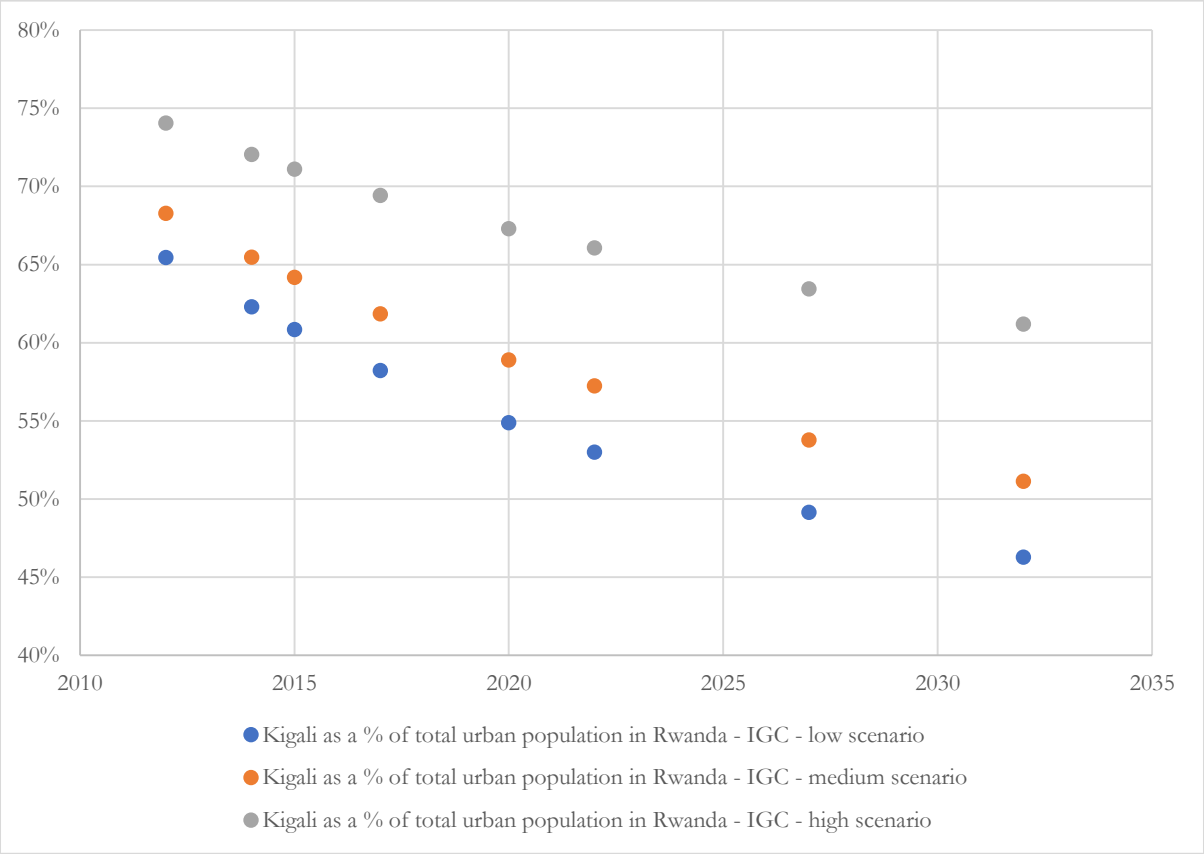
Figure 11 and Figure 12 show the resulting population projections under the high, medium, and low, population projections. These are compared with observed population sizes from previous national surveys, and specific population projections for given years made by the Kigali Master Plan (labelled and colour coded on the graphs). The first graph displays trends on a long horizon, until 2070, to illustrate the nature of declining logistic growth. The second projects the population on a more manageable horizon, until 2040.

The third, fourth and fifth projections give similar results using slightly different methodologies and different projected carrying capacities. They are so similar, and it is unclear which methodology is superior, so henceforth, when we estimate housing need we take the average of the low version of each scenario, to get an amalgamated "IGC" low estimate, and do the same for medium and high estimates.

We compare our population projections against National Institute of Statistics (NISR) forecasts of Rwanda's total urban population in Figure 13. NISR's 'medium' scenarios project a total Rwanda population of 16.3 million by 2032, 4.9 million of whom should be urban.[18] Under our high Kigali growth scenario, the share of Rwanda's urban population in Kigali decreases from approximately 65% in 2012 to 61% by 2032. In the medium scenario, it falls to 51%. In the low scenario, Kigali's share of the national urban population falls to 46%. Given the growth of secondary cities and alternative urban corridors, this seems plausible.

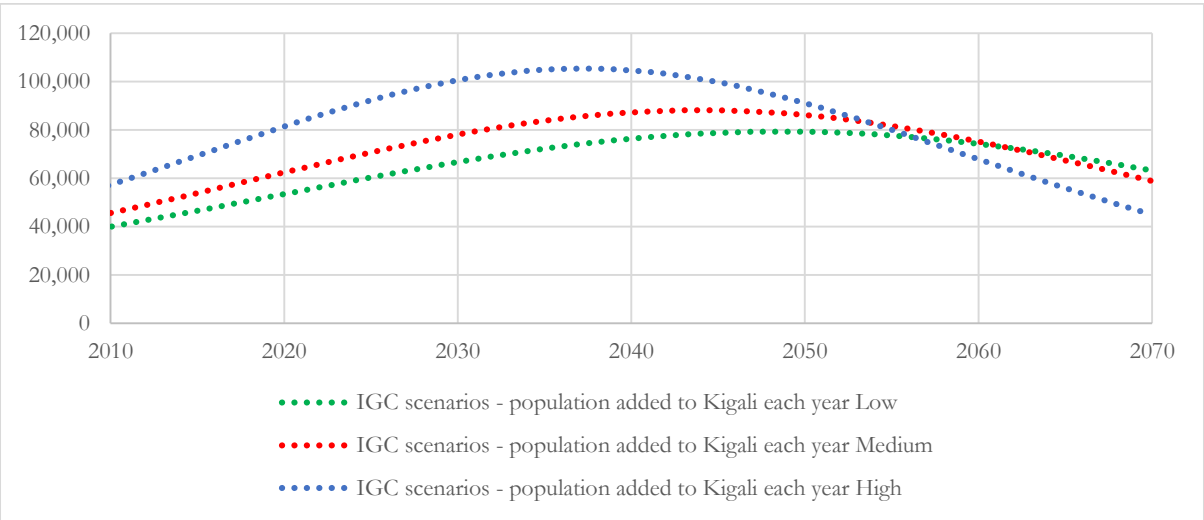
[18] NISR's 'medium' scenario assumes a 30 percent urbanisation rate by 2032. It should be noted that Rwanda is currently changing its definition of 'urban', which is likely to raise the official and projected rates; however, it is reasonable to compare the Kigali population to the urbanisation rate under old definitions for the sake of projections.

Figure 13: Share of national urban population in Kigali under three scenarios.



Critical for planning housing is to translate the *absolute* population expected in each given year into the *new* population added to the city's population annually. This is also another important 'check' on the projections. Figure 14 shows the numbers added by the IGC projections. In the 'high' scenario, in 2018, 77,000 people are added to Kigali's population annually, rising to 103,000 by 2032. In the 'medium scenario, 59,000 people are added to Kigali's population each year in 2018, rising to 81,000 by 2032. In the 'low' scenario, Kigali's population increases by 51,000 annually in 2018, rising to 69,000 by 2032.

Figure 14: Population added to Kigali each year under three scenarios



The Excel model that accompanies this paper allows users to adjust population growth assumptions then observe the impact on population projections and housing demand forecasts.

Table 6: Population growth data points, existing projections and full version of projections for this study

	Data points		Existing projections				IGC projections								
Year	Census	EICV	First Scenario (Master Plan)	Curve fit to first Scenario (Master Plan)	Second Scenario (UN)	NISR Total Urban (Kigali + other urban areas)	Third scenario - low	Fourth scenario - low	Fifth scenario - low	Third scenario - medium	Fourth scenario - medium	Fifth scenario - medium	Third scenario - high	Fourth scenario - high	Fifth scenario - high
2002	765,325			522,082			765,325	765,325	765,325	765,325	765,325	765,325	765,325	765,325	765,325
2003				566,363			796,970	796,770	796,772	800,375	800,443	800,444	807,365	807,475	807,477
2004				613,955			829,754	829,333	829,336	836,818	836,952	836,956	851,405	851,625	851,629
2005				665,028	857,214		863,702	863,039	863,043	874,692	874,889	874,894	897,506	897,834	897,840
2006		703,000		719,749			898,840	897,912	897,918	914,032	914,285	914,292	945,728	946,157	946,166
2007				778,276			935,196	933,976	933,984	954,870	955,175	955,185	996,126	996,651	996,663
2008				840,758			972,792	971,255	971,265	997,241	997,589	997,601	1,048,755	1,049,364	1,049,380
2009				907,332			1,011,652	1,009,770	1,009,783	1,041,174	1,041,557	1,041,572	1,103,665	1,104,345	1,104,364
2010				978,117	1,044,145		1,051,800	1,049,542	1,049,558	1,086,701	1,087,106	1,087,124	1,160,900	1,161,634	1,161,658
2011		1,059,087		1,053,210			1,093,257	1,090,591	1,090,610	1,133,847	1,134,262	1,134,283	1,220,503	1,221,270	1,221,299
2012	1,132,686		1,210,000	1,132,686		1,732,175	1,136,042	1,132,935	1,132,957	1,182,639	1,183,047	1,183,073	1,282,509	1,283,284	1,283,319
2013				1,216,589			1,180,175	1,176,590	1,176,616	1,233,099	1,233,482	1,233,512	1,346,947	1,347,700	1,347,741
2014		1,318,590		1,304,931		1,962,945	1,225,671	1,221,572	1,221,601	1,285,246	1,285,584	1,285,619	1,413,840	1,414,536	1,414,584
2015			1,460,000	1,397,688	1,256,994	2,086,390	1,272,547	1,267,893	1,267,926	1,339,098	1,339,368	1,339,407	1,483,204	1,483,802	1,483,857
2016				1,494,796			1,320,814	1,315,563	1,315,601	1,394,669	1,394,843	1,394,888	1,555,044	1,555,499	1,555,562
2017		1,630,657		1,596,147		2,347,098	1,370,483	1,364,592	1,364,635	1,451,967	1,452,016	1,452,068	1,629,361	1,629,618	1,629,691
2018			1,740,000	1,701,590			1,421,564	1,414,986	1,415,034	1,510,999	1,510,890	1,510,949	1,706,143	1,706,144	1,706,227
2019				1,810,925			1,474,061	1,466,748	1,466,802	1,571,768	1,571,464	1,571,530	1,785,369	1,785,047	1,785,141
2020				1,923,905	1,484,049	2,773,222	1,527,979	1,519,880	1,519,939	1,634,269	1,633,731	1,633,804	1,867,008	1,866,289	1,866,396
2021			2,060,000	2,040,236			1,583,316	1,574,379	1,574,445	1,698,497	1,697,679	1,697,761	1,951,018	1,949,821	1,949,941

2022				2,159,577		3,081,153	1,640,071	1,630,241	1,630,314	1,764,439	1,763,294	1,763,385	2,037,345	2,035,582	2,035,716
2023				2,281,548			1,698,238	1,687,458	1,687,538	1,832,077	1,830,553	1,830,655	2,125,925	2,123,499	2,123,648
2024			2,420,000	2,405,727			1,757,808	1,746,018	1,746,107	1,901,390	1,899,431	1,899,542	2,216,680	2,213,487	2,213,653
2025				2,531,659	1,846,509		1,818,767	1,805,907	1,806,004	1,972,350	1,969,894	1,970,017	2,309,522	2,305,450	2,305,634
2026				2,658,862			1,881,101	1,867,107	1,867,213	2,044,922	2,041,904	2,042,040	2,404,350	2,399,280	2,399,483
2027			2,790,000	2,786,835		3,934,920	1,944,788	1,929,596	1,929,712	2,119,067	2,115,419	2,115,567	2,501,052	2,494,857	2,495,081
2028				2,915,063			2,009,807	1,993,349	1,993,476	2,194,741	2,190,389	2,190,551	2,599,505	2,592,053	2,592,298
2029				3,043,029			2,076,130	2,058,337	2,058,475	2,271,893	2,266,759	2,266,935	2,699,574	2,690,725	2,690,994
2030			3,150,000	3,170,217	2,267,541		2,143,725	2,124,528	2,124,678	2,350,466	2,344,467	2,344,659	2,801,114	2,790,723	2,791,016
2031				3,296,126			2,212,557	2,191,885	2,192,047	2,430,397	2,423,448	2,423,656	2,903,972	2,891,888	2,892,207
2032				3,420,276		4,899,655	2,282,589	2,260,368	2,260,543	2,511,618	2,503,629	2,503,854	3,007,982	2,994,052	2,994,398
2033			3,510,000	3,542,210			2,353,776	2,329,933	2,330,122	2,594,056	2,584,932	2,585,176	3,112,975	3,097,040	3,097,415
2034				3,661,510			2,426,073	2,400,532	2,400,736	2,677,631	2,667,277	2,667,540	3,218,773	3,200,672	3,201,077
2035				3,777,794			2,499,428	2,472,115	2,472,334	2,762,260	2,750,575	2,750,858	3,325,190	3,304,764	3,305,199
2036			3,850,000	3,890,722			2,573,789	2,544,627	2,544,862	2,847,854	2,834,734	2,835,038	3,432,040	3,409,125	3,409,593
2037				4,000,000			2,649,096	2,618,010	2,618,262	2,934,319	2,919,659	2,919,985	3,539,132	3,513,567	3,514,068
2038				4,105,384			2,725,290	2,692,203	2,692,472	3,021,557	3,005,250	3,005,599	3,646,271	3,617,897	3,618,433
2039			4170000	4,206,674			2,802,305	2,767,142	2,767,429	3,109,467	3,091,404	3,091,777	3,753,266	3,721,927	3,722,498
2040				4,303,718			2,880,074	2,842,759	2,843,065	3,197,946	3,178,016	3,178,414	3,859,923	3,825,468	3,826,075
2041				4,396,410			2,958,526	2,918,985	2,919,311	3,286,884	3,264,977	3,265,401	3,966,053	3,928,335	3,928,979
2042				4,484,686			3,037,589	2,995,748	2,996,094	3,376,173	3,352,178	3,352,628	4,071,469	4,030,349	4,031,031
2043				4,568,523			3,117,186	3,072,974	3,073,341	3,465,701	3,439,508	3,439,985	4,175,992	4,131,336	4,132,057
2044				4,647,934			3,197,240	3,150,586	3,150,976	3,555,356	3,526,855	3,527,361	4,279,445	4,231,130	4,231,891
2045				4,722,963			3,277,671	3,228,507	3,228,920	3,645,024	3,614,108	3,614,642	4,381,662	4,329,573	4,330,374
2046				4,793,684			3,358,399	3,306,659	3,307,095	3,734,592	3,701,154	3,701,718	4,482,484	4,426,516	4,427,357
2047				4,860,197			3,439,341	3,384,961	3,385,421	3,823,947	3,787,885	3,788,479	4,581,760	4,521,820	4,522,701

2048				4,922,620			3,520,413	3,463,333	3,463,818	3,912,977	3,874,191	3,874,815	4,679,351	4,615,356	4,616,278
2049				4,981,089			3,601,532	3,541,695	3,542,205	4,001,573	3,959,966	3,960,622	4,775,128	4,707,006	4,707,969
2050				5,035,754			3,682,615	3,619,964	3,620,500	4,089,625	4,045,105	4,045,794	4,868,974	4,796,665	4,797,668
2051				5,086,775			3,763,577	3,698,063	3,698,625	4,177,030	4,129,510	4,130,231	4,960,781	4,884,239	4,885,282
2052				5,134,316			3,844,334	3,775,909	3,776,499	4,263,685	4,213,082	4,213,835	5,050,456	4,969,643	4,970,727
2053				5,178,550			3,924,806	3,853,426	3,854,044	4,349,491	4,295,728	4,296,515	5,137,915	5,052,809	5,053,933
2054				5,219,648			4,004,909	3,930,536	3,931,182	4,434,354	4,377,360	4,378,180	5,223,088	5,133,676	5,134,839
2055				5,257,784			4,084,566	4,007,164	4,007,837	4,518,183	4,457,894	4,458,747	5,305,915	5,212,197	5,213,399
2056				5,293,128			4,163,696	4,083,234	4,083,937	4,600,895	4,537,250	4,538,138	5,386,349	5,288,335	5,289,576
2057				5,325,848			4,242,226	4,158,678	4,159,410	4,682,407	4,615,356	4,616,278	5,464,352	5,362,064	5,363,342
2058				5,356,108			4,320,081	4,233,424	4,234,186	4,762,646	4,692,143	4,693,098	5,539,900	5,433,367	5,434,683
2059				5,384,066			4,397,190	4,307,407	4,308,199	4,841,543	4,767,548	4,768,537	5,612,977	5,502,240	5,503,592
2060				5,409,874			4,473,486	4,380,564	4,381,386	4,919,032	4,841,514	4,842,538	5,683,575	5,568,683	5,570,071
2061				5,433,678			4,548,903	4,452,835	4,453,686	4,995,057	4,913,991	4,915,049	5,751,698	5,632,710	5,634,132
2062				5,455,618			4,623,381	4,524,161	4,525,043	5,069,564	4,984,933	4,986,024	5,817,358	5,694,337	5,695,793
2063				5,475,824			4,696,860	4,594,490	4,595,402	5,142,508	5,054,300	5,055,424	5,880,574	5,753,591	5,755,080
2064				5,494,423			4,769,287	4,663,771	4,664,714	5,213,848	5,122,058	5,123,216	5,941,371	5,810,504	5,812,025
2065				5,511,531			4,840,610	4,731,958	4,732,932	5,283,549	5,188,180	5,189,370	5,999,782	5,865,115	5,866,667
2066				5,527,261			4,910,782	4,799,009	4,800,013	5,351,581	5,252,641	5,253,864	6,055,846	5,917,466	5,919,048
2067				5,541,716			4,979,761	4,864,883	4,865,917	5,417,922	5,315,425	5,316,680	6,109,606	5,967,605	5,969,216
2068				5,554,992			5,047,507	4,929,545	4,930,610	5,482,552	5,376,519	5,377,805	6,161,110	6,015,583	6,017,221
2069				5,567,182			5,113,984	4,992,965	4,994,060	5,545,458	5,435,914	5,437,232	6,210,410	6,061,454	6,063,120
2070				5,578,370			5,179,161	5,055,113	5,056,238	5,606,632	5,493,609	5,494,957	6,257,562	6,105,277	6,106,968

Table 7: Summary of population projections, annual change and annual growth

Year	Existing projections		IGC Projections: average of 3rd, 4th and 5th scenarios			IGC projections: population added to Kigali each year			IGC projections: annual growth		
	Curve fit to first Scenario (Master Plan)	Second Scenario (UN)	Low[19]	Medium	High	Low	Medium	High	Low	Med.	High
2002	524,633		765,325	765,325	765,325						
2003	568,929		796,837	800,421	807,439	31,512	35,096	42,114	4.1%	4.6%	5.5%
2004	616,502		829,474	836,909	851,553	32,637	36,488	44,114	4.1%	4.6%	5.5%
2005	667,514	857,214	863,261	874,825	897,726	33,787	37,916	46,174	4.1%	4.5%	5.4%
2006	722,123		898,223	914,203	946,017	34,962	39,378	48,291	4.1%	4.5%	5.4%
2007	780,478		934,385	955,077	996,480	36,162	40,873	50,463	4.0%	4.5%	5.3%
2008	842,717		971,771	997,477	1,049,166	37,385	42,400	52,686	4.0%	4.4%	5.3%
2009	908,963		1,010,402	1,041,434	1,104,124	38,631	43,957	54,958	4.0%	4.4%	5.2%
2010	979,322	1,044,145	1,050,300	1,086,977	1,161,398	39,898	45,543	57,273	3.9%	4.4%	5.2%
2011	1,053,877		1,091,486	1,134,131	1,221,024	41,186	47,154	59,627	3.9%	4.3%	5.1%
2012	1,132,686		1,133,978	1,182,919	1,283,037	42,492	48,789	62,013	3.9%	4.3%	5.1%
2013	1,215,776		1,177,794	1,233,364	1,347,463	43,816	50,445	64,425	3.9%	4.3%	5.0%
2014	1,303,143		1,222,948	1,285,483	1,414,320	45,154	52,119	66,857	3.8%	4.2%	5.0%
2015	1,394,745	1,256,994	1,269,455	1,339,291	1,483,621	46,507	53,808	69,301	3.8%	4.2%	4.9%
2016	1,490,498		1,317,326	1,394,800	1,555,368	47,871	55,509	71,748	3.8%	4.1%	4.8%
2017	1,590,279		1,366,570	1,452,017	1,629,557	49,244	57,217	74,189	3.7%	4.1%	4.8%
2018	1,693,918		1,417,195	1,510,946	1,706,171	50,625	58,929	76,614	3.7%	4.1%	4.7%
2019	1,801,199		1,469,204	1,571,587	1,785,186	52,009	60,641	79,015	3.7%	4.0%	4.6%
2020	1,911,861	1,484,049	1,522,599	1,633,935	1,866,565	53,396	62,348	81,379	3.6%	4.0%	4.6%
2021	2,025,599		1,577,380	1,697,979	1,950,260	54,781	64,045	83,696	3.6%	3.9%	4.5%
2022	2,142,064		1,633,542	1,763,706	2,036,215	56,162	65,727	85,954	3.6%	3.9%	4.4%
2023	2,260,868		1,691,078	1,831,095	2,124,357	57,536	67,389	88,143	3.5%	3.8%	4.3%
2024	2,381,588		1,749,977	1,900,121	2,214,606	58,899	69,026	90,249	3.5%	3.8%	4.2%
2025	2,503,771	1,846,509	1,810,226	1,970,753	2,306,868	60,249	70,632	92,262	3.4%	3.7%	4.2%
2026	2,626,942		1,871,807	2,042,955	2,401,037	61,581	72,202	94,169	3.4%	3.7%	4.1%
2027	2,750,610		1,934,699	2,116,685	2,496,997	62,892	73,730	95,959	3.4%	3.6%	4.0%
2028	2,874,275		1,998,877	2,191,894	2,594,619	64,179	75,209	97,622	3.3%	3.6%	3.9%
2029	2,997,439		2,064,314	2,268,529	2,693,764	65,437	76,635	99,145	3.3%	3.5%	3.8%
2030	3,119,610	2,267,541	2,130,977	2,346,531	2,794,285	66,663	78,002	100,520	3.2%	3.4%	3.7%
2031	3,240,313		2,198,830	2,425,833	2,896,022	67,853	79,303	101,738	3.2%	3.4%	3.6%
2032	3,359,096		2,267,833	2,506,367	2,998,811	69,003	80,533	102,789	3.1%	3.3%	3.5%
2033	3,475,536		2,337,944	2,588,055	3,102,477	70,110	81,688	103,666	3.1%	3.3%	3.5%
2034	3,589,245		2,409,114	2,670,816	3,206,841	71,170	82,761	104,364	3.0%	3.2%	3.4%

[19] The third, fourth and fifth projections give similar results using slightly different methodologies and different projected carrying capacities. They are so similar, and it is unclear which methodology is superior, so henceforth, when we estimate housing need we take the average of the low version of each scenario, to get an amalgamated "IGC" low estimate, and do the same for medium and high estimates. These numbers will be the foundation of the remainder of the study.

2035	3,699,876		2,481,293	2,754,564	3,311,718	72,179	83,748	104,877	3.0%	3.1%	3.3%
2036	3,807,122		2,554,426	2,839,209	3,416,919	73,133	84,644	105,202	2.9%	3.1%	3.2%
2037	3,910,724		2,628,456	2,924,654	3,522,255	74,030	85,446	105,336	2.9%	3.0%	3.1%
2038	4,010,465		2,703,322	3,010,802	3,627,534	74,866	86,148	105,278	2.8%	2.9%	3.0%
2039	4,106,179		2,778,959	3,097,550	3,732,564	75,637	86,748	105,030	2.8%	2.9%	2.9%
2040	4,197,739		2,855,299	3,184,792	3,837,155	76,341	87,242	104,592	2.7%	2.8%	2.8%
2041	4,285,064		2,932,274	3,272,421	3,941,122	76,975	87,629	103,967	2.7%	2.8%	2.7%
2042	4,368,112		3,009,810	3,360,327	4,044,283	77,536	87,906	103,161	2.6%	2.7%	2.6%
2043	4,446,878		3,087,834	3,448,398	4,146,462	78,023	88,072	102,179	2.6%	2.6%	2.5%
2044	4,521,392		3,166,267	3,536,524	4,247,489	78,434	88,126	101,027	2.5%	2.6%	2.4%
2045	4,591,710		3,245,033	3,624,591	4,347,203	78,766	88,067	99,714	2.5%	2.5%	2.3%
2046	4,657,916		3,324,051	3,712,488	4,445,452	79,018	87,897	98,249	2.4%	2.4%	2.3%
2047	4,720,116		3,403,241	3,800,103	4,542,094	79,190	87,615	96,641	2.4%	2.4%	2.2%
2048	4,778,434		3,482,521	3,887,328	4,636,995	79,280	87,224	94,901	2.3%	2.3%	2.1%
2049	4,833,006		3,561,811	3,974,053	4,730,034	79,289	86,726	93,040	2.3%	2.2%	2.0%
2050	4,883,984		3,641,027	4,060,175	4,821,103	79,216	86,122	91,068	2.2%	2.2%	1.9%
2051	4,931,524		3,720,088	4,145,590	4,910,101	79,062	85,415	88,998	2.2%	2.1%	1.8%
2052	4,975,788		3,798,914	4,230,201	4,996,942	78,826	84,610	86,841	2.1%	2.0%	1.8%
2053	5,016,944		3,877,425	4,313,911	5,081,552	78,511	83,711	84,610	2.1%	2.0%	1.7%
2054	5,055,157		3,955,542	4,396,631	5,163,868	78,117	82,720	82,316	2.0%	1.9%	1.6%
2055	5,090,594		4,033,189	4,478,275	5,243,837	77,646	81,644	79,969	2.0%	1.9%	1.5%
2056	5,123,419		4,110,289	4,558,761	5,321,420	77,101	80,486	77,583	1.9%	1.8%	1.5%
2057	5,153,790		4,186,771	4,638,014	5,396,586	76,482	79,253	75,166	1.9%	1.7%	1.4%
2058	5,181,865		4,262,563	4,715,962	5,469,317	75,792	77,949	72,731	1.8%	1.7%	1.3%
2059	5,207,792		4,337,599	4,792,543	5,539,603	75,035	76,580	70,286	1.8%	1.6%	1.3%
2060	5,231,715		4,411,812	4,867,695	5,607,443	74,213	75,152	67,840	1.7%	1.6%	1.2%
2061	5,253,772		4,485,141	4,941,365	5,672,847	73,329	73,671	65,403	1.7%	1.5%	1.2%
2062	5,274,094		4,557,528	5,013,507	5,735,829	72,387	72,142	62,983	1.6%	1.5%	1.1%
2063	5,292,805		4,628,917	5,084,077	5,796,415	71,389	70,571	60,586	1.6%	1.4%	1.1%
2064	5,310,022		4,699,257	5,153,041	5,854,633	70,340	68,963	58,219	1.5%	1.4%	1.0%
2065	5,325,856		4,768,500	5,220,366	5,910,521	69,243	67,325	55,888	1.5%	1.3%	1.0%
2066	5,340,409		4,836,601	5,286,029	5,964,120	68,101	65,663	53,599	1.4%	1.3%	0.9%
2067	5,353,780		4,903,520	5,350,009	6,015,475	66,919	63,980	51,356	1.4%	1.2%	0.9%
2068	5,366,058		4,969,221	5,412,292	6,064,638	65,700	62,283	49,163	1.3%	1.2%	0.8%
2069	5,377,329		5,033,669	5,472,868	6,111,662	64,449	60,576	47,023	1.3%	1.1%	0.8%
2070	5,387,672		5,096,837	5,531,733	6,156,602	63,168	58,865	44,941	1.3%	1.1%	0.7%

ii. Number of people per household and per house

Household size includes live-in household staff, children, and anyone who has stayed in the household for more than six months (such as friends or extended family).[20] In EICV surveys, a household is not defined by all the people living in one house or dwelling unit, but by a group of people that eat at least one daily meal together or who are collectively receiving institutionalised care. Where two households share the same physical structure – as in a subdivided house – these households are counted and analysed separately. There is thus not inevitably one household per house; in fact, in 2011, the ratio of households per house was 1.01; in 2014, this ratio was 1.11 and for 2017 it rose again to 1.20. Whilst this is a striking increase in a short time, it does not necessarily reflect shortages of quantity of housing, or overcrowding, although either are possible; this question is addressed in section 3 iv. It follows that to calculate the number of new houses required, we must divide estimates of the population size by estimates of the number of people living in each house or dwelling unit[21], and not the number of people per household.

EICV 3 from 2011 estimates a mean household size of 4.7 persons, EICV 4 from 2014 estimates 4.5 persons, and EICV 5 from 2017 estimates 4.0 persons per household. The 2012 Census, by contrast, estimates a mean household size in Kigali of 3.9 persons. It would be unusual for household sizes to fluctuate so dramatically, and these discrepancies are more likely the result of differences in survey methodology. We proceed using the EICV estimate of household size, as data collection for the EICVs is more closely controlled, reducing error.

Ot is worth noting that using the Census surveys makes a dramatic difference to the number of households in Kigali, and to housing demand, when compared to using EICV surveys. Taking the (lower) population estimate of the 2012 census, for example, the mean household size of 4.7 (EICV 3) suggests a total of 241,000 households in Kigali, whereas the mean household size from EICV 4 suggests 290,400 households in Kigali – a difference of 50,000 households, comprising an error margin of about 20 percent.

Table 8: Mean household sizes in Kigali province, EICVs and 2012 Census

Survey	**Household size** *(Mean)*	**Implied Number of Households in 2012** *(2012 census population divided by household size)*
EICV 3 (2011)	4.7	241,000
Census (2012)	3.9	290,400
EICV 4 (2014)	4.5	251,700
EICV 5 (2017)	4.0	284,598

Another reason to use the EICV estimates is that only the EICV contains data on both household size and incomes at the household level. With the EICV, we can observe differences in household size by income quintile. Typically, lower-income people live in larger households. However, larger households can also have higher household incomes, because more adults are in the house and thus contribute to household income. In Kigali, household sizes are for this reason in fact higher the higher in higher income quintile

[20] The census counts as a household member anyone who has been resident in the house for at least six months prior to the Census night (16 July 2012). Those resident for less than six months were considered resident in their former households, except for:

1. Women recently joining the household due to marriage;
2. Public servants recently posted to a new area with their families;
3. Single member households, whereby the person recently moved to a new location.

[21] The term house and the term dwelling unit are used interchangeably in this paper

households. For example, the mean household size for households in Quintile One was 2.84 in 2017, while the mean household size in Quintile Five was 5.78, as shown in Table 9.

Table 9: Mean household size by household income quintile, EICV 3, 4 and 5

	Kigali Mean	Q1	Q2	Q3	Q4	Q5
2011	4.74	3.48	4.33	4.44	5.14	6.33
2014	4.47	3.39	3.85	4.15	5.01	5.93
2017	3.98	2.84	3.25	3.70	4.33	5.78
Annual % change 2011 - 2017	-2.9%	-3.3%	-4.7%	-3.0%	-2.8%	-1.5%

Table 10: Mean number of people per house by household income quintile, EICV 3, 4 and 5

	Kigali Mean	Q1	Q2	Q3	Q4	Q5
2011	4.79	3.51	4.37	4.48	5.19	6.39
2014	4.96	3.75	4.55	4.75	5.46	6.16
2017	4.79	3.48	4.08	4.61	5.31	6.27
Annual % change 2011 - 2014	1.2%	2.2%	1.4%	1.9%	1.7%	-1.2%
Annual % change 2011 - 2017	0.0%	-0.1%	-1.2%	0.5%	0.4%	-0.3%

Table 10 gives the same figures by house. Interestingly, whilst the number of people per household has gone down fairly steadily between 2011 and 2017, the number of people per house first increased between 2011 and 2014 and then decreased back to similar levels in 2017. The Kigali mean number of people per house has not changed although the number of people per household has fallen significantly. Clearly this is explained by the rising ratio of households per house.

Planners should not take these household and house sizes to be the only typical values for each income quintile. For each quintile, a variety of house sizes are in fact needed, from individual units, for example for job seekers, to small family units or shared houses, to extended family units with space for staff. Whilst the mean household size for Q1 households was 2.8 in 2017, this quintile will contain a lot of one-person households, and some far more populous households.

We now consider the annual change in household sizes, to project household sizes over time. Between EICV 3 and EICV 5, the mean household size in Kigali declined by 2.9 percent annually. However, it is unrealistic to expect such a high decrease for too long, because this would result in low household sizes unheard of in Africa, and would probably result in a very high household to house ratio. To generate an average rate of decrease for household size, as well as number of people per house, we searched for historical statistics for rate of decrease in household size from six African countries over the past two decades, and found an average of 1.2%. We take this as the medium rate of decrease, with a slower decrease of 0.7% for the 'higher household size' scenario and a faster decrease of 1.7% for the lower scenario.

There are also contradictory statistics for Kigali for house size and household size: EICV found a figure of 4.79 people per house and 3.98 people per household in 2017, whereas a survey by IPAR found a figure of 5.18 people per house for 2018, which using the households per house ratio from EICV 5 of 1.2, implies a household size of 4.32. We use the former as a low scenario and the latter as a high scenario, and points

half way between as a medium scenario. The results are shown in Figure 15 for household size and Figure 16 for number of people per house. A crucial assumption is that the number of people per house remains at the EICV 5 level of 1.2; whilst it is possible that this may increase in the short term, its increase may be limited or reversed if housing markets are made to work better resulting in supply keeping up sufficiently with the growth in the number of households. In the Excel model accompanying this paper, policy-makers can amend these assumptions and observe the effects on housing need.

Figure 15: Projections for mean household size by scenario

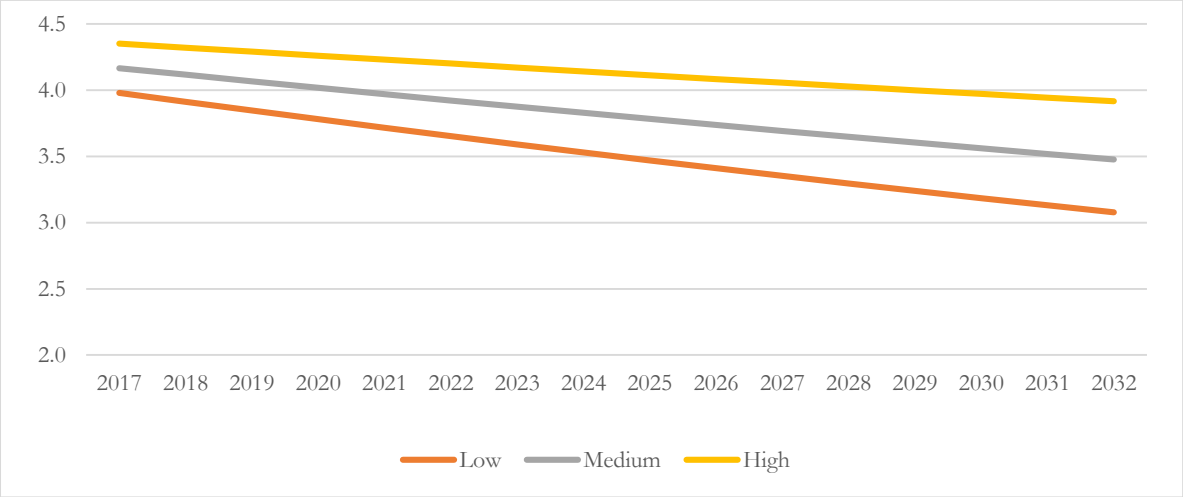


Figure 16: Projections for mean number of people per house by scenario

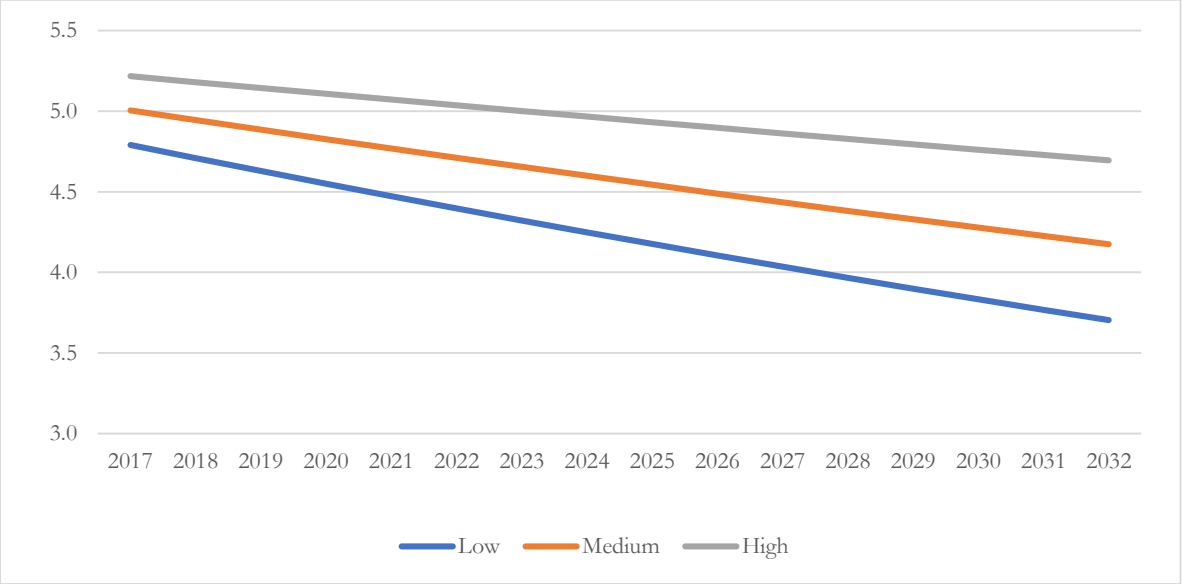


Table 11: Rates of decrease of number of people per house and household size, by scenario

	Low	Medium	High
Rate of decrease	1.7%	1.2%	0.7%

Table 12 shows the projected mean household sizes and number of people per house in Kigali by scenario.

Table 12: Projected mean household sizes and number of people per house in Kigali by scenario

Year	Number of people per household			Number of people per house		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
2015	4.12	4.27	4.41	4.96	5.13	5.29
2016	4.05	4.22	4.38	4.87	5.07	5.25
2017	**3.98**	4.17	4.35	**4.79**	5.00	5.22
2018	3.91	4.12	**4.32**	4.71	4.94	**5.18**
2019	3.85	4.07	4.29	4.63	4.88	5.14
2020	3.78	4.02	4.26	4.55	4.83	5.11
2021	3.72	3.97	4.23	4.47	4.77	5.07
2022	3.65	3.92	4.20	4.40	4.71	5.04
2023	3.59	3.88	4.17	4.32	4.65	5.00
2024	3.53	3.83	4.14	4.25	4.60	4.97
2025	3.47	3.78	4.11	4.18	4.54	4.93
2026	3.41	3.74	4.08	4.11	4.49	4.90
2027	3.35	3.69	4.06	4.04	4.44	4.86
2028	3.30	3.65	4.03	3.97	4.38	4.83
2029	3.24	3.60	4.00	3.90	4.33	4.79
2030	3.18	3.56	3.97	3.83	4.28	4.76
2031	3.13	3.52	3.94	3.77	4.23	4.73
2032	3.08	3.48	3.92	3.70	4.18	4.69

Bold numbers are data points – from EICV 5 for the low scenarios and from IPAR for the high scenarios.

iii. Total Housing Need Projections

Dividing the projected population by *projected mean household size* gives *projected number of households*. Table 13 shows these estimates for Kigali, under the low, medium, and high population scenarios, and the small, medium, and large household size scenarios. Dividing the projected population by projected number of *people per house* gives projected *number of houses needed*. shows these estimates for Kigali, under the low, medium, and high population scenarios, and the small, medium, and large household size scenarios.

However, the ratio of households per house in EICV 5 is 1.2. This study is about housing need rather than housing demand, so we do not focus on trying to project the households per hosue ratio into the future. Instead our analysis is built on the principle that we are estimating housing need; if the number of households per house rises much more than 1.2, it will be a symptom that housing need is not being met and that housing supply is not keeping up with demand. We thus assume that this ratio holds constant. Our estimated total number of households can then be interpreted as a maximum figure for housing need if the household per house ratio ever falls back down to one, and our estimated total number of houses needed is a more plausible estimate that assumes the ratio stays at its current level.

Figure 17 is derived from Table 13 and shows the total number of households in Kigali shown by projections based on the medium household size scenario, which rises from 367,078 households in 2018 to 721,036 households in 2032, in the medium population growth scenario, with quite a wide range of between 579,212 households in 2032 for the large households, low growth scenario, to 974,471 households in 2032 for the small households, high growth scenario. Figure 18 is directly from Table 14, and shows the number of additional households that Kigali will need to accommodate per year. This rises from 18,550 households in 2018, to 23,769 households in 2024, to 31,542 in 2032 under the medium population growth scenario. However, changing parameters around household size and population growth gives some variation in the number of new households estimated, which ranges from 12,955 per year in 2018 in the large households, low growth scenario, to 23,950 per year in the small households, high growth scenario for 2018. In 2032, the range is from 21,555 to 49,400 new households per year. The wide ranges for these figures underscore the significant data gaps for understanding housing need in Kigali, even before supply is considered.

We now discuss the number of houses needed in Kigali. Figure 19 is derived from Table 15 and shows the projected total number of houses needed in Kigali based on the medium household size scenario. This number rises from 305,594 houses in 2018 to 600,266 households in 2032, in the medium population growth scenario, with quite a wide range of between 483,050 households in 2032 for the large households, low growth scenario, to 809,675 households in 2032 for the small households, high growth scenario.

Figure 20 is an important figure, taken directly from Table 16, and shows the number of additional houses that Kigali will need per year. This rises from 15,443 houses in 2018, to 19,788 houses in 2024, to just under 26,259 in 2032 under the medium population growth scenario. As above, changing parameters around household size and population growth gives some variation in the year-by-year additional housing need estimated, which ranges from 11,620 per year in 2018 in the large households, low growth scenario, to 22,155 per year in the small households, high growth scenario for 2018. In 2032, the range is from 17,976 to 41,045 new houses per year.

Figure 17: Total number of households by year (medium household size scenario)

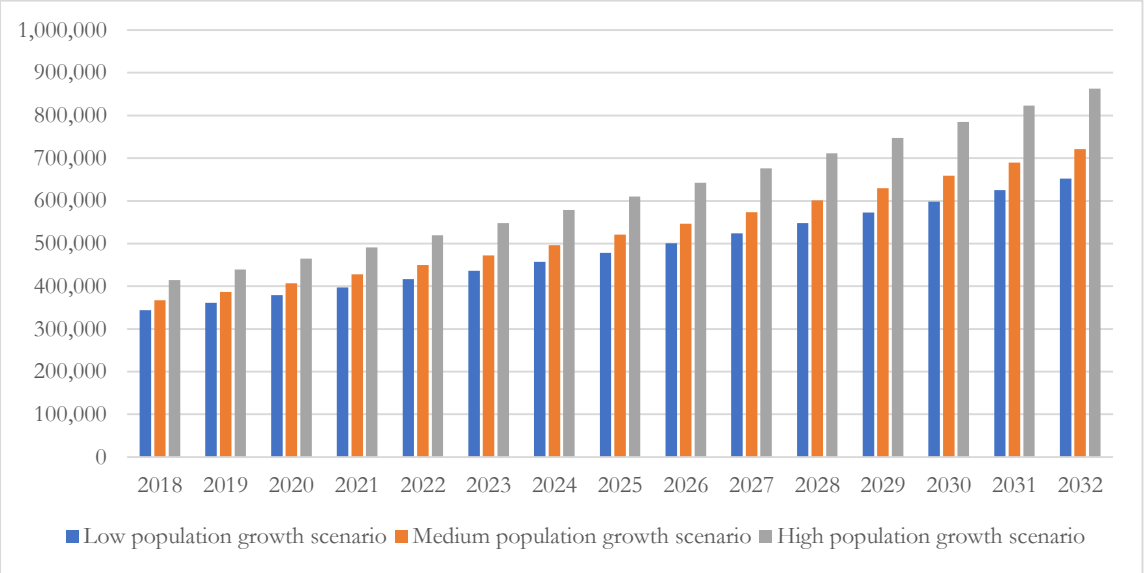


Figure 18: Additional households to accommodate per year (medium household size scenario)

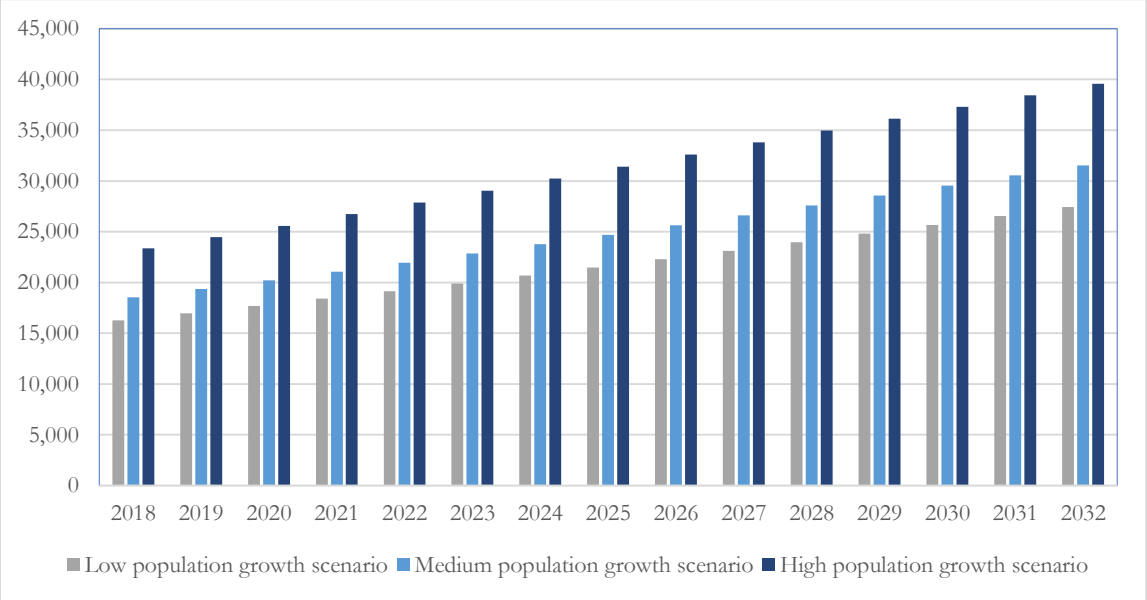


Figure 19: Total number of houses needed by year (medium household size scenario)

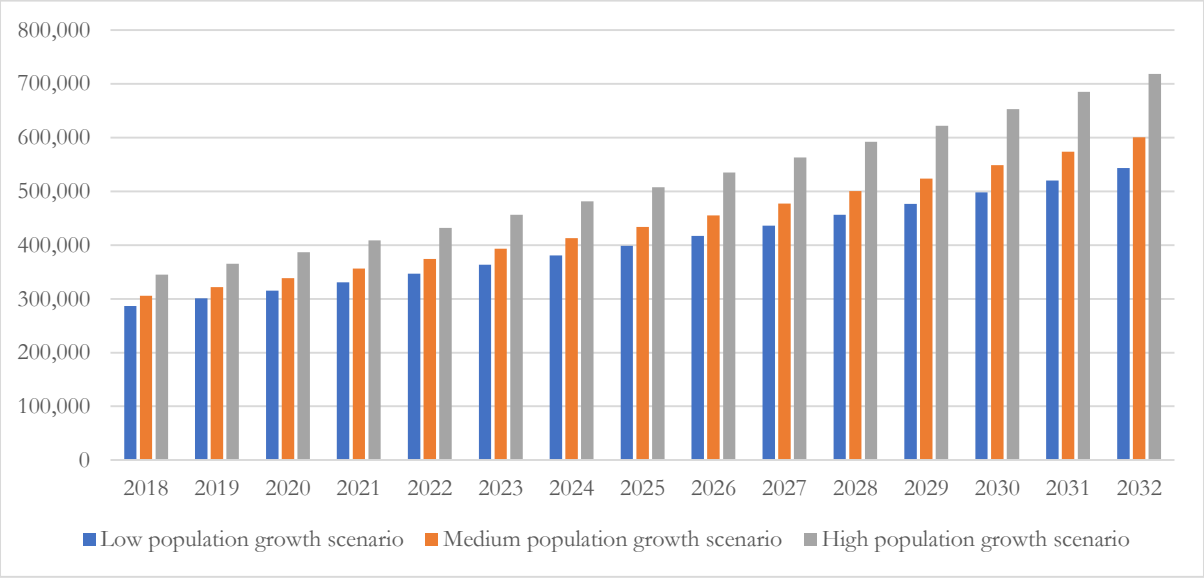


Figure 20: Additional houses needed per year (medium household size scenario)

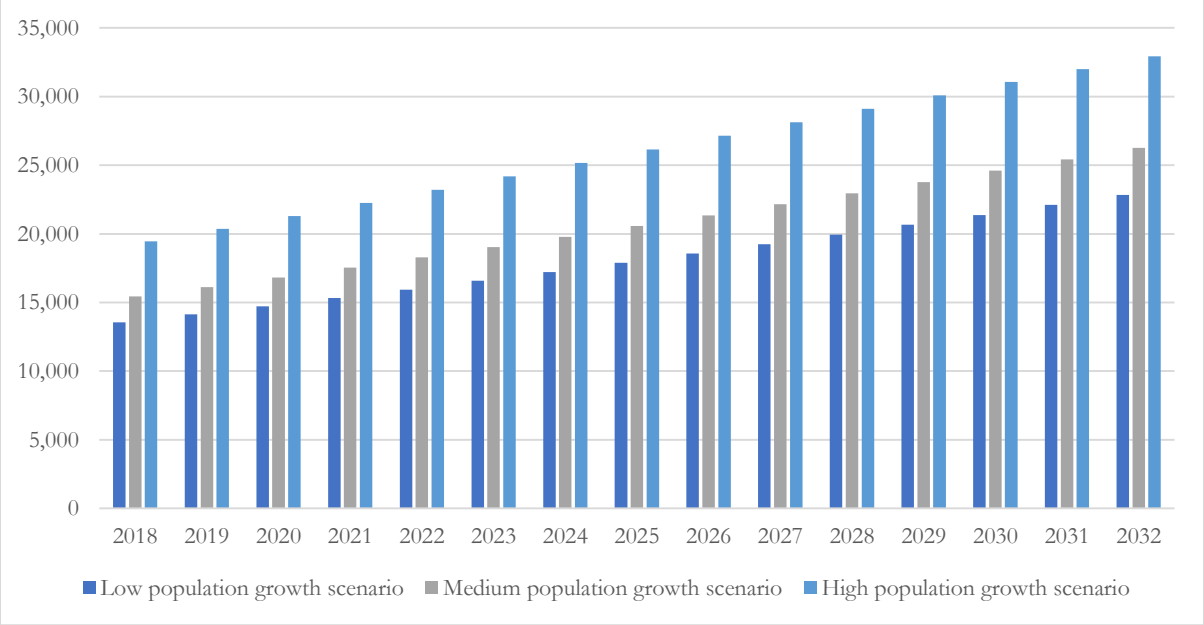


Table 13: Projection of total number of households in Kigali by year, for three household size scenarios[22]

	Low Population Growth			Medium Population Growth			High Population Growth		
Year	**Small Households Scenarios**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**
2018	362,242	344,301	328,054	386,205	367,078	349,756	436,106	414,507	394,947
2019	382,030	361,272	342,491	408,652	386,448	366,358	464,193	438,971	416,151
2020	402,761	378,949	357,440	432,212	406,659	383,577	493,748	464,556	438,188
2021	424,468	397,352	372,911	456,921	427,731	401,422	524,809	491,282	461,064
2022	447,183	416,497	388,910	482,816	449,684	419,900	557,415	519,165	484,778
2023	470,940	436,404	405,447	509,932	472,537	439,017	591,601	548,217	509,328
2024	495,770	457,088	422,526	538,306	496,305	458,777	627,400	578,448	534,709
2025	521,708	478,568	440,154	567,972	521,006	479,186	664,840	609,865	560,911
2026	548,785	500,858	458,335	598,963	546,654	500,243	703,947	642,470	587,924
2027	577,033	523,975	477,075	631,311	573,262	521,950	744,741	676,262	615,731
2028	606,485	547,931	496,375	665,049	600,841	544,306	787,241	711,236	644,314
2029	637,171	572,742	516,238	700,204	629,401	567,308	831,457	747,382	673,650
2030	669,122	598,418	536,666	736,806	658,950	590,951	877,400	784,687	703,714
2031	702,368	624,972	557,658	774,880	689,493	615,229	925,071	823,135	734,476
2032	736,938	652,414	579,212	814,450	721,036	640,135	974,471	862,703	765,907

[22] The total number of households is calculated as the total population divided by the mean household size.

Table 14: Additional households to accommodate in year (total number of households in year minus total number in previous year)

	Low Population Growth			Medium Population Growth			High Population Growth		
Year	**Small Households Scenarios**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**
2018	18,878	16,283	13,933	21,372	18,550	15,994	26,664	23,364	20,375
2019	19,788	16,971	14,437	22,447	19,370	16,602	28,088	24,464	21,203
2020	20,731	17,677	14,949	23,560	20,211	17,219	29,554	25,585	22,038
2021	21,707	18,402	15,471	24,709	21,072	17,845	31,061	26,726	22,876
2022	22,715	19,146	16,000	25,895	21,953	18,478	32,606	27,882	23,714
2023	23,756	19,907	16,536	27,117	22,852	19,117	34,186	29,052	24,550
2024	24,831	20,685	17,079	28,374	23,769	19,761	35,799	30,231	25,381
2025	25,938	21,480	17,628	29,666	24,701	20,408	37,440	31,417	26,203
2026	27,077	22,290	18,182	30,991	25,648	21,057	39,107	32,605	27,013
2027	28,249	23,116	18,739	32,349	26,608	21,707	40,794	33,792	27,807
2028	29,452	23,957	19,300	33,737	27,579	22,356	42,499	34,974	28,583
2029	30,686	24,810	19,863	35,156	28,560	23,002	44,217	36,146	29,336
2030	31,951	25,677	20,428	36,602	29,549	23,643	45,942	37,306	30,064
2031	33,246	26,554	20,992	38,074	30,544	24,278	47,672	38,447	30,763
2032	34,570	27,442	21,555	39,570	31,542	24,905	49,400	39,568	31,430

Table 15: Projection of total number of houses needed in Kigali by year, for three household size scenarios

	Low Population Growth			Medium Population Growth			High Population Growth		
Year	**Small Households Scenarios**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**
2018	300,982	286,633	273,590	320,893	305,594	291,688	362,354	345,079	329,377
2019	317,424	300,761	285,629	339,544	321,720	305,534	385,692	365,446	347,060
2020	334,649	315,477	298,097	359,119	338,546	319,894	410,248	386,746	365,439
2021	352,685	330,797	310,999	379,649	356,089	334,776	436,057	408,995	384,517
2022	371,559	346,736	324,342	401,165	374,365	350,187	463,149	432,207	404,294
2023	391,297	363,308	338,133	423,696	393,389	366,130	491,554	456,393	424,768
2024	411,929	380,529	352,377	447,271	413,177	382,610	521,298	481,561	445,935
2025	433,480	398,410	367,078	471,920	433,741	399,630	552,407	507,716	467,787
2026	455,978	416,967	382,241	497,670	455,093	417,191	584,900	534,860	490,315
2027	479,449	436,212	397,869	524,548	477,244	435,294	618,796	562,992	513,505
2028	503,920	456,156	413,965	552,580	500,203	453,939	654,108	592,108	537,343
2029	529,417	476,811	430,531	581,790	523,980	473,122	690,847	622,200	561,808
2030	555,965	498,186	447,567	612,202	548,579	492,839	729,020	653,257	586,881
2031	583,589	520,293	465,074	643,837	574,007	513,087	768,630	685,264	612,536
2032	612,312	543,138	483,050	676,716	600,266	533,858	809,675	718,205	638,748

Table 16: Additional houses needed in year (total number of houses needed in year minus total houses needed in previous year)

	Low Population Growth			Medium Population Growth			High Population Growth		
Year	**Small Households Scenarios**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**	**Small Households Scenario**	**Medium Households Scenario**	**Large Households Scenario**
2015	15,685	13,556	11,620	17,758	15,443	13,338	22,155	19,451	16,993
2016	16,442	14,128	12,040	18,651	16,125	13,845	23,338	20,366	17,683
2017	17,225	14,716	12,467	19,575	16,826	14,360	24,556	21,300	18,379
2018	18,036	15,320	12,902	20,530	17,543	14,882	25,808	22,249	19,078
2019	18,874	15,939	13,343	21,516	18,276	15,410	27,092	23,212	19,777
2020	19,739	16,572	13,791	22,531	19,025	15,943	28,405	24,186	20,474
2021	20,631	17,220	14,244	23,575	19,788	16,480	29,745	25,168	21,167
2022	21,551	17,882	14,701	24,649	20,564	17,020	31,109	26,155	21,852
2023	22,498	18,557	15,163	25,750	21,352	17,561	32,493	27,144	22,528
2024	23,471	19,244	15,628	26,878	22,151	18,103	33,896	28,132	23,190
2025	24,471	19,944	16,096	28,032	22,960	18,644	35,312	29,116	23,837
2026	25,497	20,655	16,566	29,210	23,776	19,183	36,739	30,092	24,466
2027	26,548	21,376	17,036	30,412	24,600	19,718	38,173	31,057	25,073
2028	27,624	22,106	17,507	31,635	25,428	20,248	39,610	32,008	25,656
2029	28,723	22,845	17,976	32,878	26,259	20,771	41,045	32,941	26,212
2030	15,685	13,556	11,620	17,758	15,443	13,338	22,155	19,451	16,993
2031	16,442	14,128	12,040	18,651	16,125	13,845	23,338	20,366	17,683
2032	17,225	14,716	12,467	19,575	16,826	14,360	24,556	21,300	18,379

In Table 17 we present the *cumulative* number of new houses required for the growing population of Kigali, excluding backlog housing, since 2017, and by income quintile, assuming medium household size and medium population growth scenario. This totals 310,115 additional houses needed between 2017 to 2032, with a range of 270,061 to 392,576.

Table 17: Cumulative new houses needed to house growing population by year and quintile, since 2017 (by population scenario, assuming medium household sizes)

Year	Low population growth scenario	Medium population growth scenario	High population growth scenario
2018	13,556	15,443	19,451
2019	27,684	31,568	39,817
2020	42,400	48,394	61,117
2021	57,720	65,937	83,366
2022	73,659	84,213	106,579
2023	90,231	103,238	130,764
2024	107,451	123,025	155,932
2025	125,333	143,589	182,087
2026	143,890	164,941	209,231
2027	163,135	187,092	237,363
2028	183,079	210,052	266,479
2029	203,733	233,828	296,571
2030	225,109	258,428	327,628
2031	247,216	283,855	359,635
2032	270,061	310,115	392,576

iv. Housing Supply

There are three important sources of data on housing supply in Kigali:

- Section H of the Census survey
- Section 5 of the EICV surveys
- A classification of buildings based on aerial and satellite imagery of Kigali in 2009 and 2015, conducted by the IGC and Rapid Planning group.

We focus on the latter two data sources. EICV 4 took place in 2014 and is therefore more up to date than the latest Census, which took place in 2012. EICV data are also more regularly updated, which facilitates comparisons across years. Finally, data collection is more closely controlled for EICV than for the Census, and trained staff are spread less thinly, due to the smaller size of the survey. We thus focus on the EICV when considering housing characteristics. However, the Census benefits from surveying the entire population rather than a subsample. We thus provide Census figures for comparison where deemed appropriate, and this comparison could be extended for future studies.

EICV 3 reports a total number of 223,462 households living in 221,670 housing units. EICV 4 reports a higher total of 295,227 households in Kigali in 2014 living in 266,096 housing units, and EICV 5 has an even higher total of 409,718 households living in 340,530 houses. The 2012 Census reports a much larger number of households than EICV 3, and a smaller population size, explained by household sizes assumed to be smaller.

Table 18: Total housing units in Kigali - national survey data

Date	Source	Number of Households in Kigali	Ratio of Households per House	Total Number of Housing Units
2002	Census	161,180	*Not reported*	
2011	EICV 3	223,462	1.008	221,670
2012	Census	286,664	*Not Reported*	
2014	EICV 4	295,227	1.109	266,096
2017	EICV 5	409,718	1.203	340,530

Taking the EICV 3 and EICV 4 figures, the average annual increase in the number of households in Kigali between 2011 and 2014 was 23,922. However, the average annual increase in the number of houses built is considerably lower at 14,949. The annual average increase in the number of households between EICV 4 and EICV 5 was much higher at 38,164, and the annual average number of houses built was 24,773. The EICV 5 figures considerably exceeded expected growth based on projections built on intercensal growth rates, and is taken to be the "high population growth" scenario, which is why the estimated number of households for 2018 in the medium scenario for our study is lower than the EICV 5 figure for 2017.

The number of households per housing unit has increased from 1.01 in 2011, up to about 1.11 in 2014, rising again to 1.20 in 2017 as already discussed. This implies an increase in sharing of dwelling units with additional households between 2011 and 2017[23]. If need is indeed defined as one household per housing unit, this implies that housing supply may not keeping up with need. However, a more accurate measure of whether overcrowding is a general trend is the floor area per person, which decreased between 2011 and 2014 but changed very little between 2014 and 2017 in spite of the increase in the ratio of households per house. It may be explained as follows: first new households are sometimes accommodated by extension of

[23] Predominantly, shared dwelling units resulted when owners sub-let rooms to renters; occasionally, space was offered to households for free.

existing units. There is suggestive evidence that between 2011 and 2014, existing units were being split into multiple dwelling units: the number of bedrooms per housing unit fell from 2.37 to 2.18 and the floor area per person decreased rapidly by a significant amount, 18.8% in the three years from 2011 to 2014. However, the period between 2014 and 2017 registered a small decrease in the number of bedrooms per housing unit from 2.18 to 2.11 perhaps reflecting smaller household size, and a slower decrease increase in floor area per person. The bottom two quintiles saw a negligible change in floor size per person and the largest decreases came from the upper quintiles. This implies continued densification of residential areas over time and possibly increases in overcrowding although it is impossible to say.

Table 19: Falling floor area per person, 2011-2017 (EICV data)

Floor area (m^2) per person	Kigali (mean)	Q1	Q2	Q3	Q4	Q5
2011 (EICV 3)	14.0	10.2	9.6	10.6	14.7	24.7
2014 (EICV 4)	11.4	8.5	8.7	9.1	11.5	19.6
2017 (EICV 5)	10.6	8.4	8.5	8.4	10.0	18.0
% Change	-4.6%	-3.2%	-2.0%	-3.8%	-6.3%	-5.2%

A second source of data for total housing supply is the satellite images of Kigali. A remote sensing exercise was carried out on aerial images of Kigali in 2009, and satellite images of Kigali in August 2015, to identify building footprints and classify them into nine typologies. Full details of this exercise can be found in the January 2018 report, "Remote Sensing for Measuring Housing Supply in Kigali", by Bachofer and Murray, but an overview graphic is provided in Figure 21. This study covers only the main urban area of Kigali (the 'study area'), not counting buildings in the rural periphery. It does not cover as large a size of geographical area that the EICV and Census data cover; therefore the data are **not comparable**. The Bachofer and Murray study is most interesting for the trends it contains and for the data on building composition and its changes.

Figure 21: Overview of building footprint data for built-up area of Kigali in 2015, by building type

The study identified 189,871 buildings in 2015, and 148,823 buildings in 2009, of which 182,511 buildings in 2015 and 143,194 buildings were overwhelmingly residential based on their classifications. A breakdown is shown in Table 20.

The residential buildings are classified as either rudimentary buildings, bungalows or villas; one type of building missed out is apartments, but very few people in Rwanda live in apartment blocks and the vast majority of apartments are used commercially.

Rudimentary buildings are small (<90m^2), ground-floor-only, buildings with tin roofs, typically in unplanned settlements. This building type comprised 86 percent of residential building stock in 2009 and 83 percent in 2015, but despite this, consumed just 62 percent of the ground cover (in m^2) of all residential buildings in 2015, due to their small size.

By contrast, bungalows made up 12.6 percent of the 2009 housing stock rising to 14 percent in 2015, but consumed 29 percent of residential land in 2015. Villas were 1.4% of housing stock in 2009 and 3.1 percent in 2015, but consumed 9 percent of residential land in 2015. Thus it is clear that more modern, higher-quality houses tend to consume far more land, and are increasing relative to more rudimentary houses.

Between 2009 and 2015, approximately 39,317 residential buildings were newly built in the main urban area of Kigali, which translates to an average annual increase of 6,553. Of this annual increase, most (4,666) were 'rudimentary', 1,259 were bungalows, and 628 were villas. Areas on the north-east periphery of central Kigali that were less dense in 2009 saw the most new construction by far, whereas little new construction was seen in central areas.

Four thousand three hundred buildings were replaced or improved substantially enough to appear as new buildings and change their category. Just over 10 percent of bungalows and villas in 2015 were on sites with differently classified buildings in 2009. No rudimentary or local buildings were in this category, entailing that these are either built on previously unbuilt land, or built on land previously used for other rudimentary houses.

There was also an apparent trend of incremental home improvement. Eleven thousand nine hundred buildings were detectably improved but in ways not substantial enough to change their classification; 6% of bungalows and villas were thus improved, as were 8% of rudimentary buildings.

Five thousand three hundred buildings were demolished without rebuilding, including 4 percent of the 2009 stock of rudimentary buildings, and 1 percent of villas. Major renovations or rebuilding was most common in suburban areas of Kigali.

Table 20: Change in the number of residential buildings, 2009-2015 (Remote Sensing Data)

Building Class	Number of buildings 2009	% of 2009 buildings	Number of buildings 2015	% of 2015 buildings	2009-2015 total increase	2009 to 2015 % increase	% increase in share (2009 to 2015)
Rudimentary	120,122	82.5%	151,149	79.8%	31,027	25.8%	-2.7%
Bungalow	18,000	12.4%	25,564	13.5%	7,564	42.0%	1.1%
Villa	1,930	1.3%	5,511	2.9%	3,581	185.5%	1.6%
Total (for all 8 building classes)	145,662	100.0%	189,517	100.0%	43,855	30.1%	0.0%

Descriptive statistics about housing from EICV are also interesting, shown in Table 21, Table 22 and . Median total annual rent (including in-kind) for the third quintile has risen from 180,000 to 240,000 RWF. Rent as a percentage of total income (measured by the proxy, consumption plus savings), is virtually unchanged, moving from 9.5% to 9.8% between the two surveys. Moving house appears to have become more common, as the mean duration that households have lived in the same house, has gone down from 80 to 75 months. The proportion of households that own the house they lived in dropped 5% to 48%. The proportion of households that has water piped to their house or yard increased from 33% to 37%. Average distance to water source dropped by 8 metres to 354.

Floor area of the house, and floor per person dropped by 8 metres squared and 0.8 metres squared respectively, although the number of rooms for has dropped marginally from 2.4 to 2.2, and the number of adult equivalents per house dropped from 4.0 to 3.9.

Table 21: Kigali housing descriptive statistics by income quintile, EICV 3

	Kigali	Q1	Q2	Q3	Q4	Q5
Mean total rent paid, including in-kind and inputted (RWF, annual)	500,660	61,574	115,848	223,195	462,465	1,644,299
Median total rent, including in-kind and inputted (RWF, annual)		48,000	96,000	180,000	360,000	1,200,000
Rent as % of income (median)		9.8%	10.5%	11.5%	11.8%	15.6%
Duration (in months) of living in house	80	85	86	74	76	78
% own the house they live in	52.6%	55.7%	46.9%	44.6%	48.3%	59.0%
% households with water piped into house or yard	32.6%	3.2%	7.8%	20.5%	46.5%	85.0%
Distance to water source used (m)	362	616	518	451	189	34
Own toilet	N/A	N/A	N/A	N/A	N/A	N/A
Floor area (m^2)	54	27	33	39	56	113
Floor area (m^2) per person	14.0	10.2	9.6	10.6	14.7	24.7
Number of rooms for sleeping	2.4	1.7	2.0	2.0	2.5	3.7
Number of adult equivalents	4.0	3.0	3.8	3.8	4.4	5.1

Number of members	4.5	3.4	4.2	4.2	4.8	5.5

Table 22: Kigali housing descriptive statistics, EICV 4

	Kigali	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Mean total rent paid, including in-kind and inputted (RWF, annual)	556,690	96,445	194,560	285,951	522,625	1,684,895
Median total rent, including in-kind and inputted (RWF, annual)		81,000	180,000	240,000	480,000	1,200,000
Rent as % of income (median)		12.4%	15.1%	13.1%	15.2%	16.4%
Duration (in months) of living in house	75	79	69	72	83	73
% own the house they live in	47.8%	45.1%	43.4%	40.7%	47.7%	62.0%
% housholds with water piped into house or yard	36.8%	9.0%	15.2%	24.0%	54.6%	81.3%
Distance to water source used (m)	354	677	452	327	247	67
Own toilet	45.7%	41.4%	38.3%	34.5%	38.9%	75.2%
Floor area (m^2)	41.2	41.2	41.2	41.2	41.2	41.2
Floor area (m^2) per person	11.4	8.5	8.7	9.1	11.5	19.6
Number of rooms for sleeping	2.2	1.6	1.7	2.0	2.4	3.2
Number of adult equivalents	3.9	3.0	3.5	3.7	4.4	4.8
Number of members	4.2	3.3	3.7	4.1	4.8	5.4

Table 23: Kigali housing descriptive statistics, EICV 5

	Kigali	**Q1**	**Q2**	**Q3**	**Q4**	**Q5**
Mean total annual rent, including in kind and imputed	568,008	88,339	166,065	280,392	501,202	1,806,676
Median total annual rent, including in kind and imputed		84,000	180,000	252,000	480,000	1,351,695
Mean rent as % of consumption	17.0%	14.1%	14.1%	14.6%	15.8%	18.4%
Median rent as % of consumption		12.8%	15.3%	12.9%	15.4%	19.1%
Mean duration (in months) of living in house	61	48	58	62	66	74
% own their house	39%	30%	29%	31%	47%	56%
% HHs with water piped into house or yard	34.0%	2.5%	16.8%	25.0%	45.7%	80.1%
Mean distance to water source used (m)	409	737	510	394	265	139
Own toilet	43.7%	34.8%	27.6%	34.4%	42.8%	78.9%
Mean Floor area (m^2)	36.46	18.87	19.70	26.91	36.44	86.14
Floor area (m^2) per person	10.6	8.4	8.5	8.4	10.0	18.0

Number of rooms for sleeping	2.1	1.4	1.6	1.9	2.2	3.3
Number of adult equivalents	3.7	2.5	2.9	3.4	4.0	5.4
Number of members	4.0	2.8	3.3	3.7	4.3	5.8

v. Backlog Housing

This section assumes that the ideal situation for housing in Kigali is that houses are not overcrowded, houses should be of durable build quality, people do not live in temporary camps, and that houses are not built in locations at higher risk for natural disasters. Therefore, we attempt to quantify each of these categories and calculate a total of the number of houses that will need to be replaced or built to meet the need in 2015, taking into account any overlap between these categories when possible.

Following consultation with the City of Kigali, the following reasons emerged as to why a dwelling unit may be considered in need of replacement:[24]

- *Overcrowding*: If a house has less than 3.8m^2 per adult equivalent, it is assumed that the dwelling is overcrowded; this benchmark is selected in the absence of international standards for overcrowding, reflecting the bottom decile of floor area per capita and hence a minimum tolerance level for Kigali. In addition, houses with more than three adult equivalents per bedroom are also counted as overcrowded. In most cases the original 'crowded' house can remain, but it is assumed that an additional house is needed to properly accommodate some of the people in the original household.[25] The benchmarks selected allow for fairly high 'crowding', because we are interested in cases where an additional *house* is required, rather than, for example, an extension.
- *Low build quality*: At the recommendation of the City of Kigali (One Stop Centre), houses with the following exterior wall materials were deemed substandard and in need of replacement: Mud bricks, tree trunks with mud, tree trunks with mud and cement, wooden planks, and plastic sheets. Thirty seven percent of houses in Kigali were thus classified, substantially concentrated in lower income quintiles.
- *Temporary homes*: It is assumed that households living in a temporary camp need permanent dwellings. Only a small number of households lived in temporary camps.
- *High-risk location*: It is assumed that houses which have experienced an environmental disaster (floods, land slides, destructive rain, other) are in a precarious location and the households occupying them may require a new house elsewhere. Such an assumption may overestimate risk because some houses may be made safer through upgrading of drainage systems, erosion management practices on sloping land and other measures.

One factor not captured by the EICV surveys is the following.

- *Master Plan rezoning*: Some houses need to be replaced when they do not comply with Kigali Master Plan zoning or if their location is rezoned.

The Ministry of Infrastructure estimated in 2018 that between 15,000 and 35,000 houses will need to be demolished due to non-compliance with the Master Plan. However, as the EICV does not give household location below district level, it is impossible to know how many of these houses also meet the other non-rezoning criteria for replacement listed above. Given the broad reach of the risky location, overcrowding,

[24] The model in the 2012 EU study calculated the number of households meeting each 'unsatisfactory' criterion, and summed these totals. This overestimated the number of households in need of replacement, as the same dwelling unit could meet more than one criteria, and was thus counted multiple times. The totals and criteria from the 2012 study are shown below, for comparison.

[25] Note that people self-report floor space. In the previous model in the 2012 EU study, overcrowding was captured by the proportion of dwellings that were part of a group of enclosed dwellings with multiple households, which was 12.9% in 2013-2014, but the City of Kigali advised that shared compounds are acceptable, and a measure based on floor area is preferred.

and building quality criteria, and the greater impact of Master Plan rezoning in unplanned, low-quality, settlements, there is a large risk of double-counting if this figure is added to the existing backlog estimate. We therefore exclude a separate estimate of backlog housing derived from the rezoning figure, but accept that some buildings may need to be replaced if a decision is made to enforce the Master Plan in some areas with the result that otherwise satisfactory but non-compliant houses, are demolished. A future study might work closely with the City of Kigali to understand the implications of various Master Plan zoning and infrastructure provision options for the supply of housing.

It is also worth noting that the ratio of households to dwelling units was close to 1 in EICV 3 but rose to 1.1 in EICV 4 and 1.2 in EICV 5, which is a striking increase in a relatively short time; moreover, the ratio is highest for the lowest three income quintiles but decreases closer to one for the top two income quintiles. Whilst it would be good to aim for one household per house in the long term, a ratio higher than one is not inherently bad, unless it represents overcrowding. However, our overcrowding measure above captures this, so we do not include the number of houses required to make the households-per-house ratio one.

Table 24: Backlog indicators by quintiles and cause in Kigali, EICV 5 (2017)

Cause of Backlog	All Kigali	By Income Quintile Within Kigali				
		Q1	Q2	Q3	Q4	Q5
Total number of households	409,718	82,517	81,534	82,026	81,780	81,862
Total number of dwelling units	340,530	67,522	65,053	65,707	66,790	75,459
Total backlog dwelling units to be replaced	136,930	46,501	37,204	24,319	20,676	8,243
% of total dwelling units	40.2%	68.9%	57.2%	37.0%	31.0%	10.9%
- **Overcrowding**	54,893	17,333	15,222	11,135	7,662	3,542
% of total dwelling units	16.1%	25.7%	23.4%	16.9%	11.5%	4.7%
- **Quality**	102,132	39,454	27,147	16,402	14,298	4,831
% of total dwelling units	30.0%	58.4%	41.7%	25.0%	21.4%	6.4%
- **Temporary homes**	127	127	-	-	-	-
% of total dwelling units	0.0%	0.2%	0.0%	0.0%	0.0%	0.0%
- **Risky location**	13,079	2,607	2,774	3,131	2,919	1,648
% of total dwelling units	3.8%	3.9%	4.3%	4.8%	4.4%	2.2%

Table 25: Backlog indicators by quintiles and cause in Kigali, EICV 4 (2014)[26]

Cause of Backlog	All Kigali	By Income Quintile Within Kigali				
		Q1	Q2	Q3	Q4	Q5
Total number of households	295,227	59,310	59,051	58,942	58,887	59,038
Total number of dwelling units existing	266,210	53,481	53,247	53,148	53,099	53,235
Total backlog dwelling units to be replaced	132,551	41,851	33,256	27,370	18,357	11,716
% of total dwelling units	49.8%	78.3%	62.5%	51.5%	34.6%	22.0%
- **Overcrowding**	41,842	12,274	12,329	7,865	6,259	3,114
% of total dwelling units	15.7%	23.0%	23.2%	14.8%	11.8%	5.9%
- **Quality**	99,100	37,838	24,837	18,901	10,375	7,149
% of total dwelling units	37.2%	70.8%	46.6%	35.6%	19.5%	13.4%
- **Temporary homes**	282	-	282	-	-	-
% of total dwelling units	0.1%	0.0%	0.5%	0.0%	0.0%	0.0%
- **Risky location**	27,128	5,436	7,127	6,696	4,733	3,136
% of total dwelling units	10.2%	10.2%	13.4%	12.6%	8.9%	5.9%

In total, for 2017 we find 40.2 percent of houses in Kigali need to be replaced, considering only measures visible in the EICV 5, and a corresponding figure of 49.8% for 2014. This compares to the estimate of 48.7 percent in the EU 2012 housing market study. This reflects the increase in the average quality of housing, but also a decrease in the risky location measure. The percentages in the columns add up to more than the 40.2 percent figure or the 49.8% figure because the categories overlap; for example, some houses that are overcrowded are also of poor quality or in a risky location.

By far the highest cause of backlog housing identified by analysis of the EICV 4 and EICV 5 is poor build quality; the high figures here come from houses with mud walls uncovered by concrete. It should be noted that if houses with mud bricks *and concrete* are to be considered backlog, for EICV 4 this would count a further 54 percent of houses in Kigali as backlog in need of replacement, raising the overall backlog to be replaced to 92 percent of all dwellings in Kigali. This observation makes clear the scale of the impact of zoning codes or building regulations that disallow houses with improved, covered earth bricks.

This finding does ***not*** represent a recommendation to invest large amounts of money replacing half the housing stock; but to carefully consider the definition of backlog housing to perhaps allow certain building materials and to prioritise replacement of houses with the very lowest build quality; to consider incremental improvements rather than full replacement.

Overcrowding comprises a major backlog need, and one quarter of houses in the bottom two quintiles are classed as overcrowded in 2014 and 2017; as mentioned, overcrowding includes the bottom decile of floor area per capita as well as houses with more than three people per bedroom. Risky locations and Master Plan zoning regulations are also relatively important.

[26] The unit of analysis in EICV data is the household; however, a dwelling unit can contain more than one household. In EICV, households report the number of households with which they share the same dwelling unit. This data was used to calculate the total number of dwelling units, 266,096, from a total of 295,227 households; the ratio of households to dwelling units was 1.109 in 2014. This assumes that there are no empty dwelling units. The numbers of households reporting overcrowding, low quality, temporary homes and risky location, were then divided by the sample ratio of households to dwelling units, to get an estimated number of dwelling units for each category.

Despite the new measures applied, these findings are quite consistent with those of the EU study, in which build quality and overcrowding were the major causes of backlog housing. However, build quality is emphasised more in our study, due to stricter criteria requested by the City of Kigali.

Below, we compare the new estimates with the figures in the 2012 EU Housing Demand Study.

Table 26: Backlog by quintile and cause in Kigali, 2011

Assumption in 2011 model	***% of dwellings needing to be replaced***	
	All Kigali, 2011 (EU 2012 Housing Demand Study)	All Kigali, 2014 (new criteria)
Total	45.7%	49.8%
Due to overcrowding *It was assumed without evidence that half of currently rented units were overcrowded subdivisions.*	16.7%	15.7%
Due to quality *It was assumed that DUs with uncovered walls (mudbrick + trunks) needed to be replaced because of low-quality*	19.5%	37.2%
Due to homelessness *It was assumed that these households living in a temporary camp or HH with a different occupancy status need permanent dwellings*	0.6%	0.1%
Due to risky location *Not considered in 2012 study*	n/a	10.2%

vi. Housing Need Projections Including Backlog Housing

Considering both the needs of the growng population for housing and the backlog of housing needing to be replaced, we can estimate the total number of new houses needed in Kigali from 2018 to 2032.

In Table 27 we present the *cumulative* number of new houses required for the growing population of Kigali, including backlog housing. This is the total number of new houses required since 2017, by each given year thereafter. Table 28 presents the number of new houses needed to be built per year, a non-cumulative, flow measure. The two tables assume that all backlog housing is built over a five-year period between 2019 and 2024, both because it is unrealistic for all of the backlog to be cleared in one year, and because this paper is written in 2018 and to our knowledge this backlog housing has not yet been built. In Table 28 the figures in all other years reflect the additional annual houses needed thereafter to sustain the household to house ratio found in EICV 5 of 1.2.

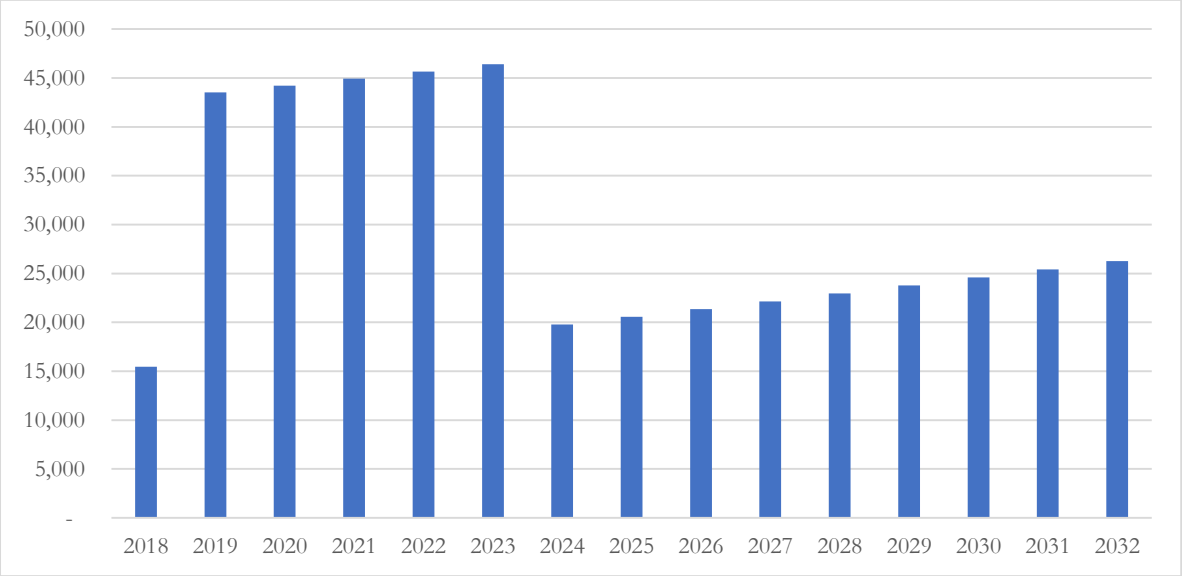
Table 27: Cumulative new houses needed to house growing population, including backlog, by year and quintile, since 2017 (assuming medium population growth, medium household sizes), assuming the backlog is filled over a five--year period from 2019 to 2024.

Year	Kigali	Q1	Q2	Q3	Q4	Q5
2018	15,445	3,035	2,960	2,973	3,030	3,419
2019	58,959	15,505	13,491	10,940	10,330	8,639
2020	103,174	28,113	24,157	19,043	17,766	14,013
2021	148,105	40,861	34,960	27,283	25,344	19,546
2022	193,770	53,753	45,904	35,665	33,065	25,241
2023	240,184	66,793	56,991	44,191	40,934	31,103
2024	259,975	70,682	60,784	48,000	44,816	35,484
2025	280,542	74,724	64,725	51,958	48,851	40,037
2026	301,897	78,921	68,818	56,068	53,041	44,765
2027	324,052	83,275	73,063	60,332	57,387	49,670
2028	347,015	87,788	77,464	64,751	61,892	54,754
2029	370,795	92,461	82,021	69,328	66,558	60,019
2030	395,399	97,296	86,736	74,063	71,385	65,466
2031	420,831	102,294	91,610	78,957	76,374	71,096
2032	447,094	107,455	96,643	84,012	81,526	76,910

Table 28: Additional new houses per year needed to house growing population and backlog houses, by year and quintile, since 2017 (assuming medium population growth, medium household sizes), assuming the backlog is filled over a five-year period from 2019 to 2024.

Year	Kigali	Q1	Q2	Q3	Q4	Q5
2018	15,445	3,035	2,960	2,973	3,030	3,419
2019	43,514	12,470	10,532	7,968	7,299	5,219
2020	44,214	12,607	10,666	8,102	7,437	5,374
2021	44,932	12,748	10,803	8,241	7,578	5,533
2022	45,665	12,893	10,944	8,382	7,721	5,695
2023	46,414	13,040	11,087	8,526	7,868	5,861
2024	19,791	3,889	3,793	3,809	3,883	4,381
2025	20,567	4,042	3,941	3,958	4,035	4,553
2026	21,355	4,197	4,092	4,110	4,190	4,728
2027	22,155	4,354	4,246	4,264	4,346	4,905
2028	22,963	4,513	4,401	4,419	4,505	5,084
2029	23,780	4,673	4,557	4,577	4,665	5,265
2030	24,604	4,835	4,715	4,735	4,827	5,447
2031	25,432	4,998	4,874	4,895	4,989	5,630
2032	26,263	5,161	5,033	5,055	5,153	5,814

Figure 22: Additional new houses per year needed to house growing population and backlog houses needed, by year and quintile, since 2017 (assuming medium population growth, medium household sizes), assuming the backlog is filled over a five-year period from 2019 to 2024.



To meet housing need that includes backlog housing in a five-year period from 2019 to 2024, just under 45,000 new houses per year, a figure calculated by adding growth in the number of houses based on population growth, to a fifth of the total housing backlog of 136,930, need to be constructed during this period, dropping down to just under 20,000 in 2024. As noted previously, population growth will require an additional 15,000 houses per year initially, rising to 26,000 in 2032. As noted in the 'Housing Supply' section of this paper, EICV data suggests that the actual increase in the number of residential buildings per year has been an average of 14,949 per year between 2011 and 2014 and 24,773 per year between 2014 and 2017. These are clearly higher than our estimates of houses needed, and EICV implies a much higher growth rate in population than the intercensal rate. In our medium scenario, we have placed 2/3 of the weight on the intercental population growth rate, and 1/3 on the growth rate between the 2002 Census and EICV 5, which explains why our estimates are lower than figures seen in EICV. It is, however, possible that population growth has accelerated since the 2012 Census and the higher figures of houses needed predicted by the recent EICV figures, are correct; the 2022 Census will resolve that issue.

Table 29 adds sensitivity analysis to data on annual additional housing need, based on low, medium and high population growth, and low, medium and high household size scenarios.

This section has modelled meeting the housing backlog over a five-year period; clearly a decision could be made to do this at a different pace.

Table 29: Sensitivity analysis: additional houses per year needed to house growing population and backlog houses, by year and quintile, since 2017, assuming the backlog is filled over a five-year period from 2019 to 2024

	Low Population Growth			Medium Population Growth			High Population Growth		
Year	Small Households Scenarios	Medium Households Scenario	Large Households Scenario	Small Households Scenario	Medium Households Scenario	Large Households Scenario	Small Households Scenario	Medium Households Scenario	Large Households Scenario
2018	15,685	13,556	11,620	17,758	15,445	13,338	22,155	19,451	16,993
2019	16,442	14,128	12,040	18,651	16,125	13,845	23,338	20,366	17,683
2020	44,611	42,102	39,853	46,961	44,212	41,746	51,942	48,686	45,765
2021	45,422	42,706	40,288	47,916	44,929	42,268	53,194	49,635	46,464
2022	46,260	43,325	40,729	48,902	45,662	42,796	54,478	50,598	47,163
2023	47,125	43,958	41,177	49,917	46,411	43,329	55,791	51,572	47,860
2024	20,631	17,220	14,244	23,575	19,788	16,480	29,745	25,168	21,167
2025	21,551	17,882	14,701	24,649	20,564	17,020	31,109	26,155	21,852
2026	22,498	18,557	15,163	25,750	21,352	17,561	32,493	27,144	22,528
2027	23,471	19,244	15,628	26,878	22,151	18,103	33,896	28,132	23,190
2028	24,471	19,944	16,096	28,032	22,960	18,644	35,312	29,116	23,837
2029	25,497	20,655	16,566	29,210	23,776	19,183	36,739	30,092	24,466
2030	26,548	21,376	17,036	30,412	24,600	19,718	38,173	31,057	25,073
2031	27,624	22,106	17,507	31,635	25,428	20,248	39,610	32,008	25,656
2032	28,723	22,845	17,976	32,878	26,259	20,771	41,045	32,941	26,212

4. Household Purchasing Power for Housing in Kigali

This section aims to use income projections to calculate the maximum affordable rent and mortgage payments that households in Kigali can afford to pay up to 2032, and the corresponding property values and mortgage values respectively. First, we calculate and project income quintiles for all households in Kigali up to 2032; second, we calculate maximum affordable rent levels for these households and estimate the likely property value that these affordable rent levels represent; and third, we calculate the mortgage payments and thus value of the mortgage principal that Kigali households can afford to pay, by quintile.

i. Income Projections

The most complete data on incomes in Kigali comes from the national household surveys, EICV 3, EICV 4 and EICV 5.[27] There are three common ways of calculating incomes: summing all the different types of income, summing reported consumption and net savings (the only thing households can do with their income is spend, or 'consume', it, or save it), or taking consumption only to proxy for income.

Comparing the three approaches, we propose using the annual consumption measure as the most reliable and appropriate. Not only is it a proxy for net income, it is also a measure of living standards. Calculating total annual income by summing all forms of income in the EICV surveys produces income estimates that are significantly higher than consumption or consumption plus saving, which is explained by very high reported *business income*; this is because respondents were not asked to distinguish between business revenue and business profits that can be taken home as personal income. In this way personal income is thus exaggerated. Consumption plus net saving is problematic because EICV 3 reports savings deposited and savings withdrawn, whereas EICV 4 and EICV 5 report only savings deposited, which results in implausibly high figures for net savings. The consumption measure is also not perfect as a measure of income – international evidence shows people frequently misreport their spending, and consumption deviates from income in any case of net saving or net borrowing. However, since business income and savings measures in EICV so severely exaggerates household income, the consumption figure is most appropriate.

It should also be noted that neither measure accounts for the household's wealth, which in some contexts (such as many Latin American countries) has a greater impact on people's ability to afford housing than their income.

Taking the 'consumption' measure of income, we assign all households in Kigali to quintiles, with the poorest 20 percent of households in quintile one, the richest 20 percent in quintile five, and so on.

For each quintile, we present the median (middle) income, and the highest and lowest income in the quintile (with the exception of the extreme values at the bottom of the first quintile and top of the fifth quintile. We use the median rather than the mean, as means are skewed upwards by unusually high earners within the category. We also analyse how incomes are growing over time, by comparing 2011 incomes (in 2017 prices), 2014 incomes (in 2017 prices) and 2017 incomes (in 2017 prices). This is used to project incomes forward.[28]

[27] The model in the 2012 EU study used income data from Rwanda Social Standards Board, which includes registered workers only, and thus considerably overestimates incomes as informal workers tend to have lower incomes.

[28] The 2012 EU study used an annual income growth rate of 7%, based on the Vision 2020 target GDP growth rate. However, 7% was not a *per capita* growth target, so this overstates target per capita incomes. In addition, national GDP growth figures do not capture actual income growth for particular households in Kigali, due to unknown variation in the distribution of incomes across locations and households. Household income data trends are more evidence-based than targets, and more precise to the context in question.

Table 30: Household incomes in Kigali (annual, RWF)[29] by household income quintile, EICV 3, EICV 4 and EICV 5

Median Annual Household Consumption	Data	Q1 Median	Q1-Q2 Boundary	Q2 Median	Q2-Q3 Boundary	Q3 Median	Q3-Q4 Boundary	Q4 Median	Q4-Q5 Boundary	Q5 Median	
Nominal: 2001 in 2001 prices	EICV 1	**162,376**	247,359	**366,283**	481,533	**620,761**	841,789	**1,133,718**	1,566,980	**2,576,931**	
2005 in 2005 prices	EICV 2	**316,901**	473,138	**603,023**	748,172	**996,858**	1,352,310	**1,870,453**	2,802,754	**4,921,615**	
Nominal: 2011 in 2011 prices	EICV 3	**489,595**	706,537	**918,596**	1,218,381	**1,569,840**	2,165,107	**3,038,457**	4,524,358	**7,701,939**	
Nominal: 2014 in 2014 prices	EICV 4	**652,510**	918,313	**1,190,769**	1,477,911	**1,835,307**	2,387,432	**3,166,285**	4,348,919	**7,333,175**	
Real: 2001 in 2017 prices	EICV 1 & CPI	**454,812**	692,848	**1,025,951**	1,348,764	**1,738,739**	2,357,831	**3,175,519**	4,389,076	**7,217,925**	
Real: 2005 in 2017 prices	EICV 2 & CPI	**661,892**	988,217	**1,259,500**	1,562,663	**2,082,079**	2,824,492	**3,906,708**	5,853,950	**10,279,494**	
Real: 2011 in 2017 prices	EICV 3 & CPI	**642,512**	927,212	**1,205,505**	1,598,923	**2,060,155**	2,841,344	**3,987,471**	5,937,470	**10,107,520**	
Real: 2014 in 2017 prices	EICV 4 & CPI	**741,303**	1,043,276	**1,352,809**	1,679,025	**2,085,055**	2,712,313	**3,597,152**	4,940,718	**8,331,069**	
Real: 2017 in 2017 prices	EICV 5 & CPI	**656,108**	876,860	**1,179,206**	1,483,546	**1,946,879**	2,375,077	**3,112,810**	4,223,342	**7,063,385**	**Average annual growth rate - all quintiles**
Nominal income growth EICV 1 - EICV 5		**9.1%**	8.2%	**7.6%**	7.3%	**7.4%**	6.7%	**6.5%**	6.4%	**6.5%**	7.4%
Real income growth- EICV 1 - EICV 5		**2.3%**	1.5%	**0.9%**	0.6%	**0.7%**	0.0%	**-0.1%**	-0.2%	**-0.1%**	0.7%
Nominal income growth EICV 1 - EICV 4		**11.3%**	10.6%	**9.5%**	9.0%	**8.7%**	8.3%	**8.2%**	8.2%	**8.4%**	9.2%
Real income growth- EICV 1 - EICV 4		**3.8%**	3.2%	**2.2%**	1.7%	**1.4%**	1.1%	**1.0%**	0.9%	**1.1%**	1.9%

[29] Consumption

Table 31: Projected household incomes in Kigali, by quintile, with 1.3% annual real income growth (annual RWF, 2017 Prices)

Year	Kigali	Q1 Median	Q1-Q2 Boundary	Q2 Median	Q2-Q3 Boundary	Q3 Median	Q3-Q4 Boundary	Q4 Median	Q4-Q5 Boundary	Q5 Median
2018	195,026	**664,702**	888,346	**1,194,653**	1,502,980	**1,972,382**	2,406,189	**3,153,586**	4,278,666	**7,155,912**
2019	197,580	**673,410**	899,983	**1,210,302**	1,522,668	**1,998,220**	2,437,709	**3,194,897**	4,334,715	**7,249,652**
2020	200,169	**682,231**	911,773	**1,226,157**	1,542,615	**2,024,396**	2,469,642	**3,236,749**	4,391,498	**7,344,619**
2021	202,791	**691,168**	923,717	**1,242,219**	1,562,822	**2,050,914**	2,501,994	**3,279,149**	4,449,025	**7,440,831**
2022	205,447	**700,222**	935,817	**1,258,491**	1,583,295	**2,077,781**	2,534,769	**3,322,104**	4,507,305	**7,538,303**
2023	208,138	**709,395**	948,076	**1,274,977**	1,604,035	**2,104,999**	2,567,973	**3,365,623**	4,566,349	**7,637,052**
2024	210,865	**718,688**	960,495	**1,291,679**	1,625,047	**2,132,573**	2,601,613	**3,409,711**	4,626,167	**7,737,094**
2025	213,627	**728,102**	973,077	**1,308,599**	1,646,335	**2,160,509**	2,635,693	**3,454,377**	4,686,768	**7,838,447**
2026	216,426	**737,640**	985,824	**1,325,741**	1,667,901	**2,188,811**	2,670,219	**3,499,628**	4,748,163	**7,941,128**
2027	219,261	**747,303**	998,738	**1,343,108**	1,689,750	**2,217,484**	2,705,198	**3,545,472**	4,810,362	**8,045,153**
2028	222,133	**757,092**	1,011,821	**1,360,702**	1,711,885	**2,246,532**	2,740,635	**3,591,916**	4,873,376	**8,150,542**
2029	225,043	**767,010**	1,025,076	**1,378,527**	1,734,310	**2,275,961**	2,776,536	**3,638,969**	4,937,215	**8,257,311**
2030	227,991	**777,057**	1,038,504	**1,396,585**	1,757,029	**2,305,775**	2,812,908	**3,686,638**	5,001,890	**8,365,478**
2031	230,977	**787,236**	1,052,108	**1,414,880**	1,780,045	**2,335,980**	2,849,756	**3,734,931**	5,067,413	**8,475,063**
2032	234,003	**797,549**	1,065,890	**1,433,414**	1,803,363	**2,366,580**	2,887,087	**3,783,857**	5,133,794	**8,586,083**

A striking element to note from past consumption in Table 30 and projected future consumption in Table 31 is the following: whilst per capita real incomes (adjusted for inflation) in Rwanda have grown significantly, the median income per quintile in Rwanda has not . These two facts are compatible as explained below. EICV data show an average growth of real household incomes (adjusted to 2017 prices)) of between 0.7% for the period between EICV 1 in 2001 and EICV 5 in 2017, and 1.9% for the period between EICV 1 in 2001 and EICV 4 in 2014[30]. At face value, these are quite low rates of income growth given that national GDP per capita growth is much higher. There was even negative growth between 2014 and 2017, and nationally, a lower rate of poverty alleviation than between 2011 and 2014, which the EICV 5 thematic report on poverty describes as partly due to a severe drought during the period of the Census. These growth rates can be at least partially explained by two factors. First, in Kigali the number of people per household – and therefore the number of earning adults per household – has been falling quite fast in the six years up to 2017, according to EICV data. Second, high rates of migration to Kigali by poor households, perhaps accelerated by the 2016 drought as a "push" factor, push lower income households into higher income quintiles. In this explanation, individuals and even households, already living in Kigali, may get richer, but the average income of the city may be pulled down by rural to urban migration. This explanation is mathematically consistent with faster per capita income growth, and the poor households moving to Kigali also benefit by the move to an urban area. Nonetheless, the slow increase in purchasing power for the purpose of housing, is concerning.

The GINI index on income inequality for Rwanda has not changed significantly since 2000[31]. We therefore assume that income for all quintiles grows at the rate of the median income quintile, which is 1.3 percent in real terms. However, it is possible that as Kigali City develops it may become more unequal; this also depends on policy – for example the extent to which government resources go to the lowest income quintiles, for example in the form of social housing, or the extent to which financial markets can be made to work for the lower as well as the upper quintiles. This assumption can be amended in the Excel model accompanying this report to observe the impacts of alternative income growth scenarios on affordability.

ii. Housing Affordability for Tenants

Here we estimate the maximum value of a property (including house) that a tenant with a certain level of annual income can afford in three steps. First, we multiply annual income (represented as explained above by household consumption plus household savings) by an appropriate percentage that represents affordability to get a figure for annual rent; second, we calculate the appropriate ratio of house price to annual rent to use for step three; and third, we multiply annual rent by this ratio, to find an estimate of the value of a typical house that the household can afford.

In high income countries, rented housing is generally considered affordable if rent payments are no more than 30 percent of household income.[32] .However, in Kigali, households in fact spend closer to *10 percent* of their incomes on rent.[33] In fact, many countries at similar levels of income see similarly low percentages of incomes being spent on rent; poor households tend to spend high percentages on food and transport to work. Given the past trend for floor space per person to decrease and households per house to increase, it is likely that this will put upward pressure on rents. It is also possible that this percentage is an underestimation, but the affordable absolute rent figures we then calculate would not be affected by this. It is also possible that households may be willing to spend more of their income if housing quality or amenities improve.

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[30] We have taken the former as the low growth scenario and the latter as the high growth scenario, with a medium real household income growth scenario of 1.3%.

[31] World Bank Data shows that Rwanda's GINI Index was 48.5 in 2000, 52 in 2005, 47.2 in 2010 and 45.1 in 2013. Available here, accessed on 20th October 2018 https://data.worldbank.org/indicator/SI.POV.GINI

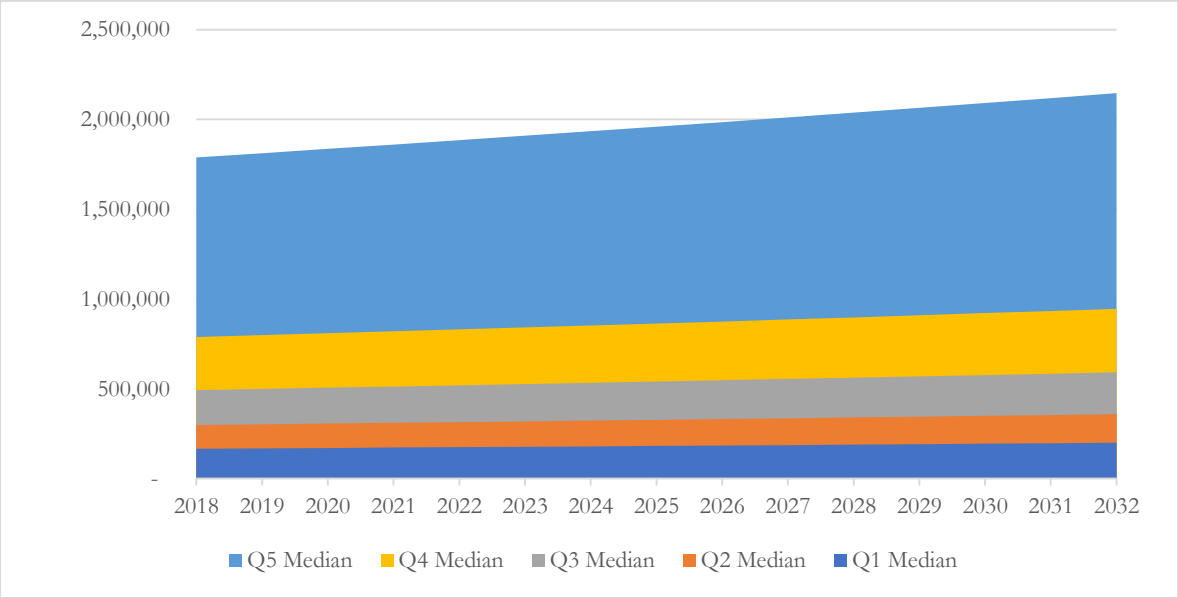
[32] Schwartz, M., & Wilson, E., (2007) Who can afford to live in a home ? A look at data from the 2006 American Community Survey. US Census Bureau. https://www.census.gov/housing/census/publications/who-can-afford.pdf

[33] Using the 'consumption plus savings' proxy for income, and considering medians in EICV 3 – 4.

UN Habitat staff have used a figure of 25% as an affordable percentage of household income to spend on housing for developing countries[34]. We therefore use this figure, but acknowledge that it is a maximum. We use this figure for both affordable rent and affordable mortgage payments.

Figure 23 shows maximum affordable annual rent by income quintile and by year; Table 32 shows the same with quintile boundaries. For the median household in the middle (third) quintile, affordable annual rent rises from around 500,000 RWF in 2018 to only around 600,000 RWF in 2032 in constant 2017 prices; the nominal figure will of course be higher.

Figure 23: Maximum affordable annual rent by income quintile(constant 2017 prices)



[34] Acioly, C. (2018) Housing At The Centre Of The New Urban Agenda: Making Housing Affordable And Accessible For All. UN Habitat. Available at https://housing-for-all.eu/fileadmin/user_upload/Presentations/Claudio_Acioly_HfA_2018_a.pdf Accessed on 2 02 2019

Table 32: Maximum affordable annual rent per household by income quintile and by year

Maximum affordable annual rent (constant 2017 prices)	Q1 Median	Q1-Q2 Boundary	Q2 Median	Q2-Q3 Boundary	Q3 Median	Q3-Q4 Boundary	Q4 Median	Q4-Q5 Boundary	Q5 Median
2018	166,176	222,087	298,663	375,745	493,096	601,547	788,397	1,069,667	1,788,978
2019	168,352	224,996	302,576	380,667	499,555	609,427	798,724	1,083,679	1,812,413
2020	170,558	227,943	306,539	385,654	506,099	617,411	809,187	1,097,875	1,836,155
2021	172,792	230,929	310,555	390,706	512,729	625,498	819,787	1,112,256	1,860,208
2022	175,056	233,954	314,623	395,824	519,445	633,692	830,526	1,126,826	1,884,576
2023	177,349	237,019	318,744	401,009	526,250	641,993	841,406	1,141,587	1,909,263
2024	179,672	240,124	322,920	406,262	533,143	650,403	852,428	1,156,542	1,934,274
2025	182,026	243,269	327,150	411,584	540,127	658,923	863,594	1,171,692	1,959,612
2026	184,410	246,456	331,435	416,975	547,203	667,555	874,907	1,187,041	1,985,282
2027	186,826	249,685	335,777	422,438	554,371	676,300	886,368	1,202,590	2,011,288
2028	189,273	252,955	340,176	427,971	561,633	685,159	897,979	1,218,344	2,037,635
2029	191,752	256,269	344,632	433,578	568,990	694,134	909,742	1,234,304	2,064,328
2030	194,264	259,626	349,146	439,257	576,444	703,227	921,659	1,250,473	2,091,370
2031	196,809	263,027	353,720	445,011	583,995	712,439	933,733	1,266,853	2,118,766
2032	199,387	266,473	358,354	450,841	591,645	721,772	945,964	1,283,449	2,146,521

We now analyse how rental values relate to house prices. We try to find, for example, what a renter typically pays each month to rent a house worth RWF 10 million, or RWF 15 million, or conversely, the typical sale value of a house that costs RWF 40,000 per month to rent.

In the EICV surveys, landlords are asked both the estimated amount in RWF that a house would receive if sold, and the estimated rental value of the house. Typically in Kigali, in 2014 the house price was 16.7 times the annual rental value. For example, if a house is rented for RWF 80,000 per month, this is equal to RWF 480,000 rent per year, and multiplying RWF 960,000s by 16.7, we arrive at an estimated house price of just over RWF 16,000,000. However, in 2017, this figure of 16.7 held only for the top two quintiles in 2017, with higher figures in the lower quintiles as shown in Table 33.

Table 33: Mean ratio of house value to annual rental value by quintile; analysis from EICV 5

Consumption quintile	Q1	Q2	Q3	Q4	Q5
Mean ratio of house value to annual rental value	22.2	22.2	20.8	16.7	16.7

We now consider the maximum affordable house price a given household can afford to rent. To calculate the final affordable *house prices* a given household, we take 25 percent of the household annual income, and multiply this figure by the appropriate ratio (for example 20.8 for the third quintile to estimate the equivalent price of such a house. For example, a household earning at the Q3 median level of about 2,000,000 RWF could afford a maximum of 500,000 RWF on rent. Multiplying this by 20.8 gives a maximum affordable house value of around 10.4 million RWF. The results in Table 34, and Figure 24 and Figure 25 give maximum affordable house values for all quintiles. Mean rents are currently a much lower proportion of income, so most tenants in these income quintiles are in reality be living in houses worth less than these values.

Figure 24: Maximum affordable house prices for tenants, (RWF, 2017 prices) by household income quintile and by year, all quintiles

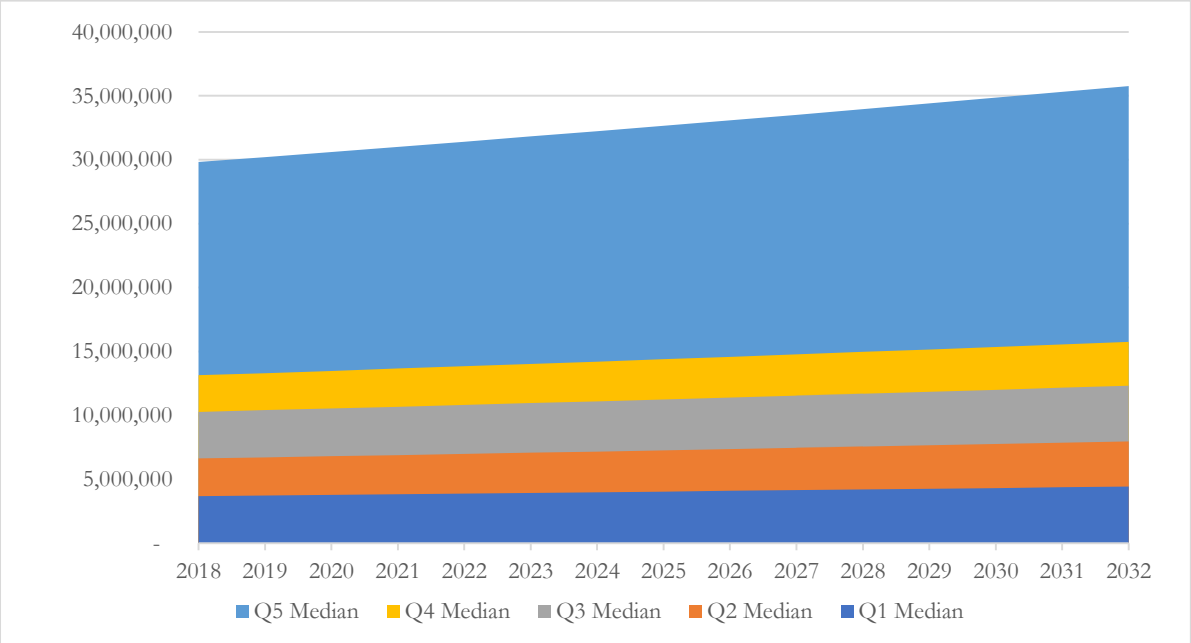


Figure 25: Maximum affordable house prices for tenants, (RWF, 2014 prices) by household income quintile and by year, bottom three quintiles

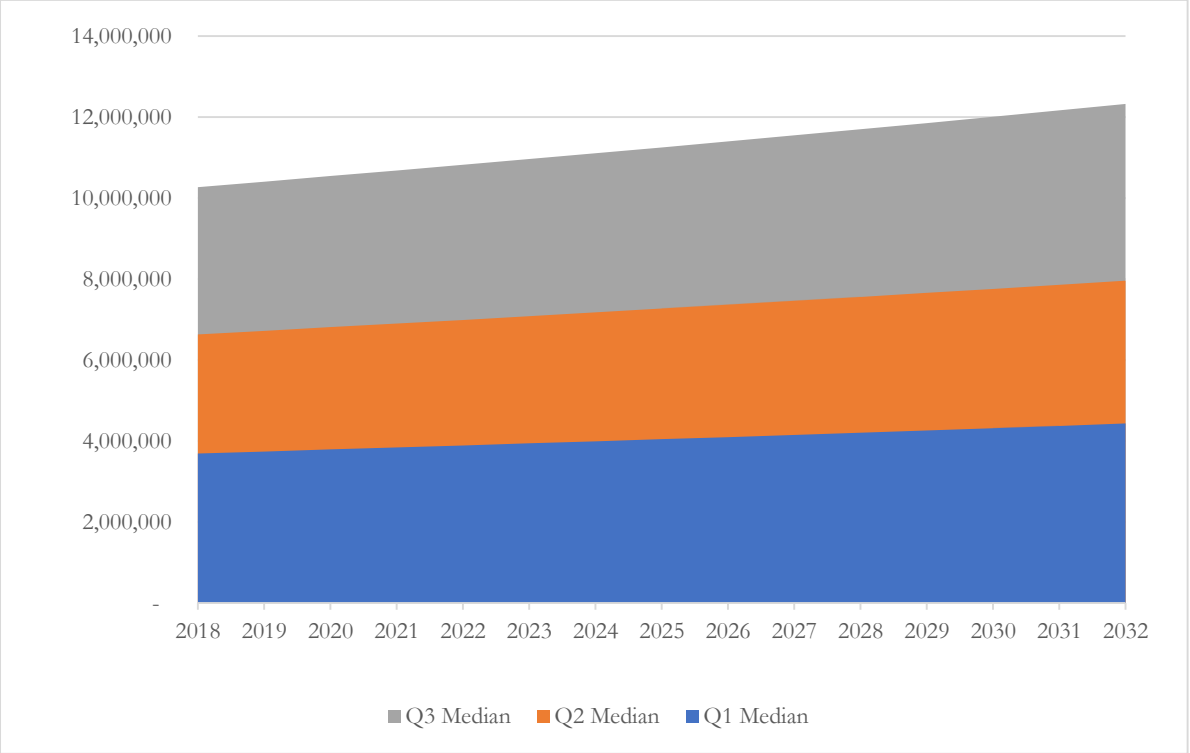


Table 34: Estimated maximum affordable house values for tenants (RWF millions, 2017 Prices) by income quintile, assuming 25 percent of income spent on rent

Maximum value of affordable house for tenants (2017 prices)	Q1 Median	Q1-Q2 Boundary	Q2 Median	Q2-Q3 Boundary	Q3 Median	Q3-Q4 Boundary	Q4 Median	Q4-Q5 Boundary	Q5 Median
2018	3,692,790	4,935,257	6,636,958	8,088,953	10,272,823	11,279,011	13,139,945	17,827,779	29,816,306
2019	3,741,165	4,999,907	6,723,900	8,194,915	10,407,393	11,426,762	13,312,073	18,061,316	30,206,888
2020	3,790,172	5,065,404	6,811,980	8,302,265	10,543,726	11,576,448	13,486,456	18,297,912	30,602,587
2021	3,839,822	5,131,759	6,901,215	8,411,022	10,681,845	11,728,095	13,663,123	18,537,608	31,003,469
2022	3,890,122	5,198,983	6,991,618	8,521,203	10,821,773	11,881,728	13,842,105	18,780,443	31,409,602
2023	3,941,081	5,267,087	7,083,205	8,632,827	10,963,534	12,037,374	14,023,431	19,026,460	31,821,055
2024	3,992,708	5,336,084	7,175,993	8,745,914	11,107,152	12,195,059	14,207,132	19,275,699	32,237,899
2025	4,045,011	5,405,985	7,269,995	8,860,482	11,252,651	12,354,810	14,393,240	19,528,203	32,660,203
2026	4,097,999	5,476,801	7,365,229	8,976,551	11,400,056	12,516,653	14,581,786	19,784,015	33,088,039
2027	4,151,681	5,548,545	7,461,711	9,094,140	11,549,392	12,680,616	14,772,802	20,043,178	33,521,479
2028	4,206,067	5,621,229	7,559,457	9,213,270	11,700,685	12,846,727	14,966,320	20,305,735	33,960,597
2029	4,261,164	5,694,865	7,658,482	9,333,960	11,853,959	13,015,014	15,162,372	20,571,733	34,405,468
2030	4,316,984	5,769,465	7,758,806	9,456,231	12,009,242	13,185,506	15,360,994	20,841,214	34,856,166
2031	4,373,535	5,845,043	7,860,443	9,580,104	12,166,558	13,358,231	15,562,217	21,114,226	35,312,768
2032	4,430,826	5,921,611	7,963,412	9,705,600	12,325,935	13,533,219	15,766,076	21,390,814	35,775,351

iii. Housing Affordability for Households with a Mortgage

Here we estimate the maximum value of a property (including house) that a household with a certain level of annual income can afford to buy using a mortgage with terms common in Kigali. This could happen according to two scenarios: first, when a household buys a pre-built property, in which case the loan amount would go towards purchasing a property; second, when a household owns land already, in which case the loan amount would go towards building a property.

Whilst we calculate affordability for all quintiles, the 2012 EU study correctly states that mortgages may only be appropriate for households above certain income levels, and that rent-to-own, other financing schemes and outright provision of social housing might be appropriate for the lowest quintiles. Whilst households in the lower quintiles are generally less likely to be offered, or involved in, formal mortgage agreements, the figures are included here for comparison with the upper quintiles, and in case housing finance does become more widely available for these quintiles. The low amounts that households in these quintiles can afford, relative to the price of the cheapest formal housing, also illustrate the need to decrease interest rates as well as to decrease the price of safe and durable housing.

Using a reversed version of a typical mortgage loan calculator, which is contained in the spreadsheet accompanying this study, we input the maximum affordable monthly mortgage payment for any given household, calculated as 25% of income, which is the same as the affordable monthly rent figure assumed in the previous sub-section; we also input the mortgage interest rate and the number of years the mortage will last, to find the maximum mortgage loan size for a household at any given input. We then input income for a household at the median of each income quintile to find the maximum affordable mortage size that this household can afford.

Mortgage interest rates in Kigali tend to range between 16.5% and 18%, and can last ten to twenty years[35]. Given that we are calculating maximum property values that households can afford in constant 2014 RWF, we adjust these nominal mortgage figures charged by banks for the 5.2% average annual inflation that Rwanda experienced for the five-year period up to 2017[36], of 16.5%, 17.3% and 20%, to generate real interest rates. Figure 26 and Figure 27, which are taken from data in Table 35, give the maximum affordable mortgage value for a mid-level scenario of 17.3% over 15 years, by median income for all quintiles. The two figures do not include down payments, for simplicity, although it is conventional in Kigali that households are required to pay at least 20% of the value of the house as a down payment. The figures show that the median household in the middle quintile can afford a mortgage of around 3.2 million RWF in 2018, rising to just 3.8 million RWF in 2032. The median household in the upper quintile can afford a mortgage of 11.6 million RWF in 2018, rising to 13.9 million RWF in 2032.

Figure 27 shows the lower quintiles more clearly, as it only includes the bottom three. The median household in the lowest quintile can afford a mortgage of around 1.1 million RWF in 2018, rising to around 1.3 million in 2032. The median household in the second quintile can afford a mortgage of around 1.9 million in 2018, rising to 2.3 million in 2032.

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[35] Accessed 20 10 2018 http://housingfinanceafrica.org/countries/rwanda/

Accessed 20 10 2018: https://house.jumia.rw/loancalculator/

A co-author of this study was given a quote for a mortgage rate of 18% from two banks in Rwanda in 2017.

[36] World Bank Data: Inflation, consumer prices (annual %) Accessed 21 10 2018 https://data.worldbank.org/indicator/fp.cpi.totl.zg

Figure 26: Maximum affordable mortgage value for mid-level scenario of a 17.3% mortgage over 15 years, by median income for all quintiles, without down payment

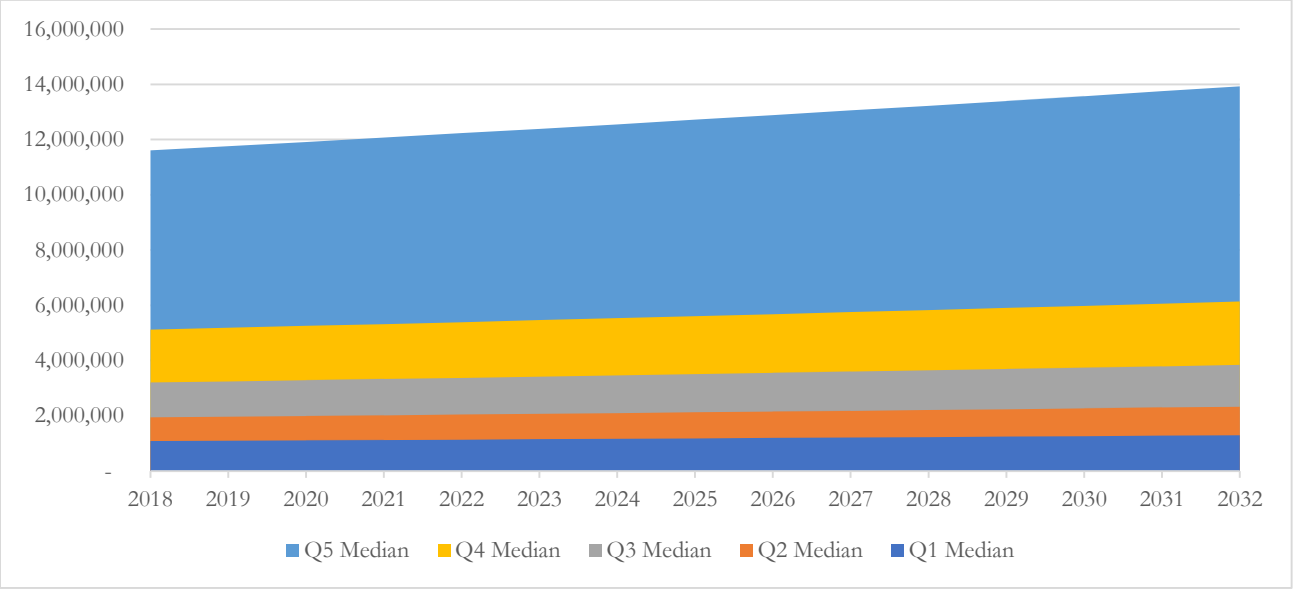
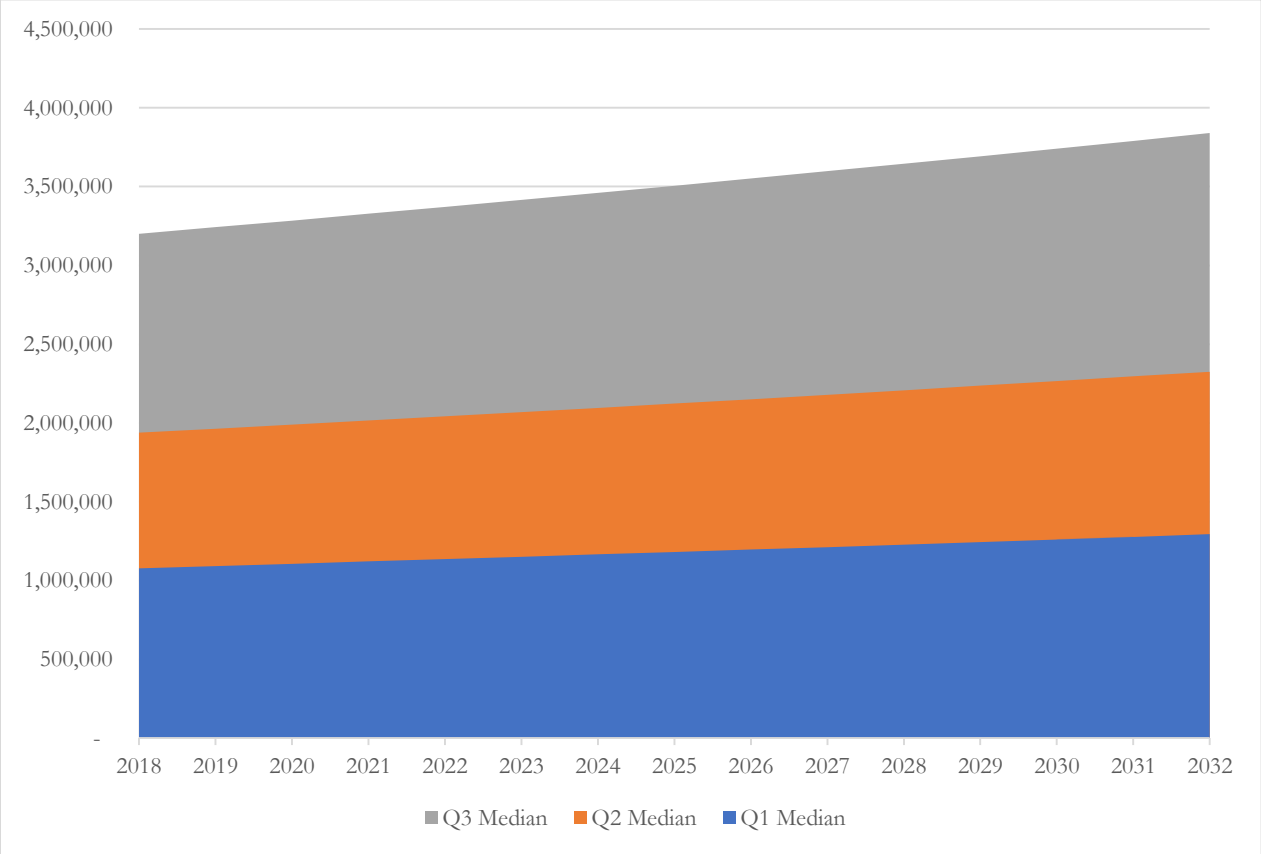


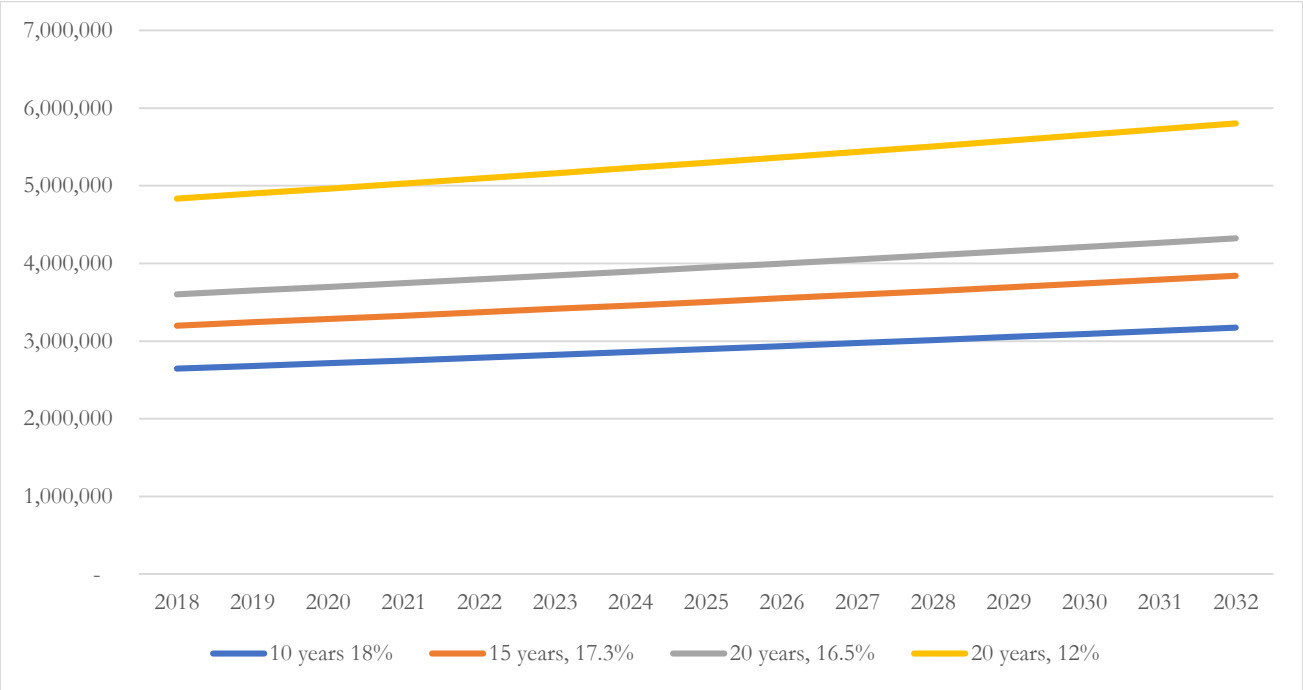
Figure 27: Maximum affordable mortgage value for mid-level scenario of a 17.3% mortgage over 15 years, by median income for the bottom three income quintiles



For sensitivity analysis based on mortgage type, Table 36 and Table 37 give the same figure – maximum affordable mortgage for the five income quintiles from 2018 to 2032– for two other mortgage scenarios in which interest rates are 18% and 16.5% respectively, and in which the mortgage lasts 10 years and 20 years respectively; these represent the scenarios that may be currently available. However, we also include a 12% interest rate over 20 years for comparison, to see the impact if this rate can be made available. If the monthly payment amount is kept the same,

a higher interest rate and shorter mortgage term will result in a smaller mortgage loan; a lower interest rate and longer mortgage will result in a larger loan. Figure 28 shows, excluding a 20% downpayment, the maximum affordable mortgage for households at the median of the middle quintile, under the four different mortgage conditions – 10 years at 18%, 15 years at 17.3%, 20 years at 16.5% and 20 years at 12%. In 2018, under the 10 year, 18% scenario, the median household can afford a mortgage worth 2.6 million RWF; under the 15 year scenario, the household can afford 3.2 million RWF and under the 20 year scenarios this rises to 3.6 million RWF for 16.5% and up to 4.8 million RWF for the 12% scenario. The same figures for 2032 are 3.1 million RWF, 3.8 million RWF, 4.3 million RWF and 5.8 million RWF respectively.

Figure 28: Maximum affordable mortgage value for 4 mortgage term scenarios for a household at the median of the Q3 quintile, without down payment



Currently in Kigali there is a requirement for a down payment of at least 20% for mortgages and often more, a demanding requirement especially for lower quintile households. Figure 29 replicates Figure 28 but with the additional 20% down payment, to give the maximum property price that a household that can afford the down payment amount, could afford to buy. Both figures are based on tables

Figure 29: Maximum affordable property values for 4 mortgage term scenarios for a household at the median of the Q3 quintile, including 20% down payment

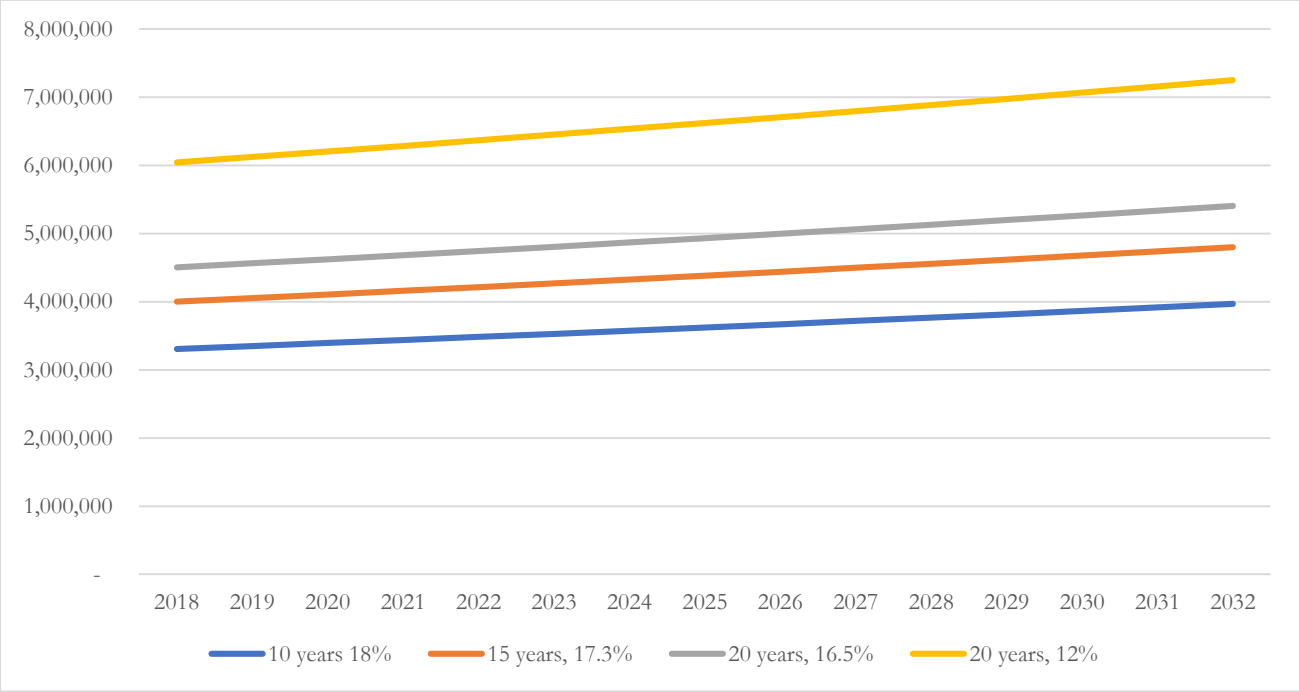


Table 35: Value of mortgage that a household can afford, assuming 17.3% mortgage over 15 years, without down payment

Year	Q1 Median	Q1-Q2 Boundary	Q2 Median	Q2-Q3 Boundary	Q3 Median	Q3-Q4 Boundary	Q4 Median	Q4-Q5 Boundary	Q5 Median
2018	1,078,456	1,441,311	1,938,282	2,438,533	3,200,122	3,903,958	5,116,584	6,941,987	11,610,218
2019	1,092,584	1,460,192	1,963,673	2,470,476	3,242,042	3,955,098	5,183,609	7,032,924	11,762,307
2020	1,106,896	1,479,320	1,989,396	2,502,839	3,284,512	4,006,909	5,251,512	7,125,053	11,916,389
2021	1,121,396	1,498,698	2,015,457	2,535,625	3,327,537	4,059,397	5,320,305	7,218,388	12,072,489
2022	1,136,086	1,518,330	2,041,858	2,568,841	3,371,127	4,112,574	5,389,999	7,312,946	12,230,634
2023	1,150,968	1,538,220	2,068,606	2,602,491	3,415,287	4,166,447	5,460,606	7,408,743	12,390,851
2024	1,166,045	1,558,370	2,095,704	2,636,583	3,460,026	4,221,026	5,532,137	7,505,795	12,553,166
2025	1,181,320	1,578,784	2,123,157	2,671,121	3,505,351	4,276,320	5,604,606	7,604,117	12,717,607
2026	1,196,795	1,599,466	2,150,969	2,706,112	3,551,270	4,332,338	5,678,024	7,703,728	12,884,203
2027	1,212,473	1,620,418	2,179,146	2,741,561	3,597,790	4,389,090	5,752,404	7,804,644	13,052,981
2028	1,228,356	1,641,645	2,207,692	2,777,474	3,644,920	4,446,585	5,827,759	7,906,882	13,223,970
2029	1,244,446	1,663,150	2,236,612	2,813,858	3,692,667	4,504,834	5,904,100	8,010,459	13,397,199
2030	1,260,748	1,684,936	2,265,911	2,850,718	3,741,039	4,563,845	5,981,441	8,115,393	13,572,697
2031	1,277,264	1,707,008	2,295,593	2,888,062	3,790,045	4,623,630	6,059,796	8,221,701	13,750,494
2032	1,293,995	1,729,369	2,325,665	2,925,894	3,839,694	4,684,198	6,139,177	8,329,403	13,930,620

Table 36: Value of mortgage that a household can afford, assuming 18% mortgage over 10 years, without down payment

Year	Q1 Median	Q1-Q2 Boundary	Q2 Median	Q2-Q3 Boundary	Q3 Median	Q3-Q4 Boundary	Q4 Median	Q4-Q5 Boundary	Q5 Median
2018	891,550	1,191,519	1,602,361	2,015,913	2,645,512	3,227,368	4,229,835	5,738,879	9,598,065
2019	903,229	1,207,128	1,623,351	2,042,321	2,680,168	3,269,645	4,285,244	5,814,057	9,723,796
2020	915,061	1,222,941	1,644,617	2,069,075	2,715,277	3,312,476	4,341,379	5,890,218	9,851,174
2021	927,048	1,238,961	1,666,160	2,096,179	2,750,846	3,355,868	4,398,249	5,967,378	9,980,221
2022	939,192	1,255,190	1,687,986	2,123,638	2,786,881	3,399,829	4,455,865	6,045,548	10,110,958
2023	951,495	1,271,633	1,710,098	2,151,457	2,823,388	3,444,365	4,514,235	6,124,743	10,243,407
2024	963,960	1,288,291	1,732,500	2,179,640	2,860,373	3,489,485	4,573,369	6,204,974	10,377,592
2025	976,587	1,305,167	1,755,195	2,208,192	2,897,843	3,535,196	4,633,279	6,286,257	10,513,534
2026	989,380	1,322,264	1,778,187	2,237,119	2,935,804	3,581,506	4,693,973	6,368,605	10,651,257
2027	1,002,340	1,339,585	1,801,481	2,266,424	2,974,261	3,628,422	4,755,462	6,452,031	10,790,785
2028	1,015,471	1,357,133	1,825,080	2,296,113	3,013,223	3,675,953	4,817,757	6,536,550	10,932,140
2029	1,028,773	1,374,911	1,848,987	2,326,192	3,052,695	3,724,106	4,880,868	6,622,176	11,075,347
2030	1,042,249	1,392,922	1,873,209	2,356,664	3,092,684	3,772,891	4,944,805	6,708,924	11,220,429
2031	1,055,903	1,411,169	1,897,747	2,387,535	3,133,197	3,822,314	5,009,580	6,796,808	11,367,413
2032	1,069,734	1,429,655	1,922,607	2,418,811	3,174,241	3,872,385	5,075,204	6,885,844	11,516,321

Table 37: Value of mortgage that a household can afford, assuming 16.5% mortgage over 20 years, without down payment

Year	Q1 Median	Q1-Q2 Boundary	Q2 Median	Q2-Q3 Boundary	Q3 Median	Q3-Q4 Boundary	Q4 Median	Q4-Q5 Boundary	Q5 Median
2018	1,214,307	1,622,870	2,182,444	2,745,710	3,603,235	4,395,732	5,761,110	7,816,455	13,072,735
2019	1,230,214	1,644,129	2,211,033	2,781,677	3,650,436	4,453,314	5,836,578	7,918,848	13,243,982
2020	1,246,330	1,665,667	2,239,997	2,818,116	3,698,255	4,511,651	5,913,035	8,022,582	13,417,473
2021	1,262,656	1,687,486	2,269,340	2,855,032	3,746,701	4,570,752	5,990,493	8,127,674	13,593,237
2022	1,279,196	1,709,592	2,299,067	2,892,432	3,795,781	4,630,627	6,068,966	8,234,144	13,771,303
2023	1,295,953	1,731,987	2,329,184	2,930,322	3,845,504	4,691,286	6,148,467	8,342,008	13,951,702
2024	1,312,930	1,754,675	2,359,696	2,968,708	3,895,879	4,752,740	6,229,010	8,451,285	14,134,464
2025	1,330,129	1,777,660	2,390,607	3,007,597	3,946,913	4,814,999	6,310,608	8,561,993	14,319,619
2026	1,347,553	1,800,947	2,421,923	3,046,995	3,998,616	4,878,074	6,393,274	8,674,152	14,507,201
2027	1,365,205	1,824,539	2,453,649	3,086,910	4,050,997	4,941,975	6,477,023	8,787,780	14,697,240
2028	1,383,089	1,848,440	2,485,791	3,127,347	4,104,063	5,006,713	6,561,870	8,902,896	14,889,768
2029	1,401,207	1,872,653	2,518,354	3,168,314	4,157,825	5,072,299	6,647,828	9,019,521	15,084,818
2030	1,419,562	1,897,184	2,551,343	3,209,818	4,212,291	5,138,744	6,734,912	9,137,673	15,282,423
2031	1,438,158	1,922,037	2,584,765	3,251,865	4,267,470	5,206,059	6,823,136	9,257,373	15,482,617
2032	1,456,997	1,947,215	2,618,624	3,294,463	4,323,372	5,274,257	6,912,517	9,378,641	15,685,433

Table 38: Comparison of mortgage value and property value that Q3 median household can afford, by mortgage type

Figures for Q3 median household	Mortgage size that Q3 median household can afford, given mortgage type, no downpayment				Mortgage size that Q3 median household can afford, given mortgage type and assuming 20% downpayment				Size of 20% downpayment required			
	10 years 18%	15 years, 17.3%	20 years, 16.5%	20 years, 12%	10 years 18%	15 years, 17.3%	20 years, 16.5%	20 years, 12%	10 years 18%	15 years, 17.3%	20 years, 16.5%	20 years, 12%
2018	2,645,512	3,200,122	3,603,235	4,835,880	3,306,891	4,000,152	4,504,043	6,044,850	661,378	800,030	900,809	1,208,970
2019	2,680,168	3,242,042	3,650,436	4,899,228	3,350,210	4,052,553	4,563,045	6,124,035	670,042	810,511	912,609	1,224,807
2020	2,715,277	3,284,512	3,698,255	4,963,406	3,394,096	4,105,639	4,622,819	6,204,257	678,819	821,128	924,564	1,240,851
2021	2,750,846	3,327,537	3,746,701	5,028,425	3,438,557	4,159,422	4,683,376	6,285,531	687,711	831,884	936,675	1,257,106
2022	2,786,881	3,371,127	3,795,781	5,094,295	3,483,601	4,213,908	4,744,726	6,367,869	696,720	842,782	948,945	1,273,574
2023	2,823,388	3,415,287	3,845,504	5,161,028	3,529,235	4,269,109	4,806,880	6,451,285	705,847	853,822	961,376	1,290,257
2024	2,860,373	3,460,026	3,895,879	5,228,636	3,575,466	4,325,033	4,869,849	6,535,795	715,093	865,007	973,970	1,307,159
2025	2,897,843	3,505,351	3,946,913	5,297,129	3,622,304	4,381,689	4,933,642	6,621,411	724,461	876,338	986,728	1,324,282
2026	2,935,804	3,551,270	3,998,616	5,366,519	3,669,754	4,439,087	4,998,270	6,708,149	733,951	887,817	999,654	1,341,630
2027	2,974,261	3,597,790	4,050,997	5,436,818	3,717,827	4,497,238	5,063,746	6,796,023	743,565	899,448	1,012,749	1,359,205
2028	3,013,223	3,644,920	4,104,063	5,508,039	3,766,529	4,556,150	5,130,079	6,885,048	753,306	911,230	1,026,016	1,377,010
2029	3,052,695	3,692,667	4,157,825	5,580,192	3,815,869	4,615,833	5,197,281	6,975,240	763,174	923,167	1,039,456	1,395,048
2030	3,092,684	3,741,039	4,212,291	5,653,290	3,865,855	4,676,299	5,265,363	7,066,613	773,171	935,260	1,053,073	1,413,323
2031	3,133,197	3,790,045	4,267,470	5,727,346	3,916,497	4,737,557	5,334,337	7,159,182	783,299	947,511	1,066,867	1,431,836
2032	3,174,241	3,839,694	4,323,372	5,802,372	3,967,801	4,799,617	5,404,215	7,252,965	793,560	959,923	1,080,843	1,450,593

Presenting the same information in a different way, taken from a World Bank affordable housing report for Vietnam, we show the effective demand for housing or purchasing power of households in each income quintile based on income, payment capacity and access to finance in **Error! Not a valid bookmark self-reference.**.

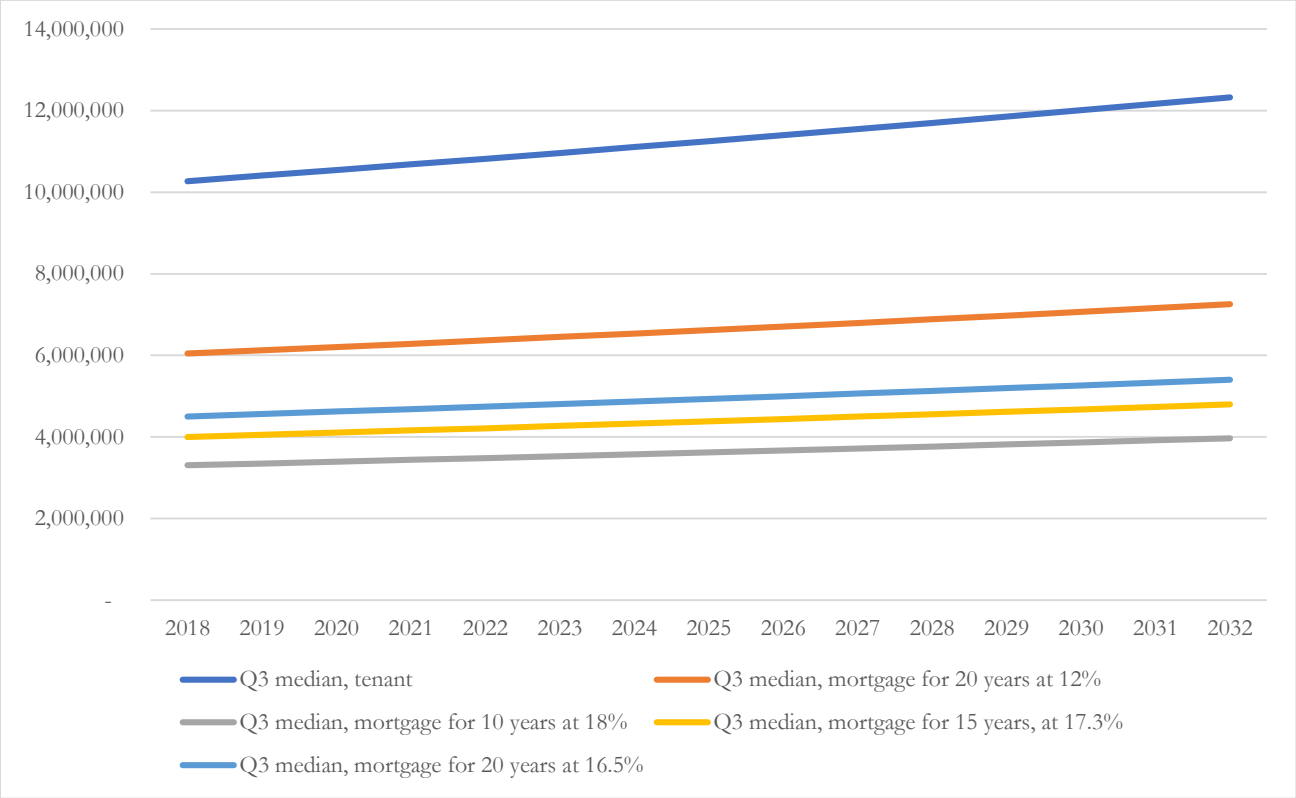
Table 39: Effective demand for housing by Household Income in Kigali Province (RWF) for 2020

Income Quintile	Median monthly income (RWF)	Payment capacity per month		Term	Rate	Loan amount (RWF)	Down payment (RWF)		Housing demand (RWF)
5	601,565	25%	150,391	15	17.3%	11,916,389	20%	2,979,097	14,895,486
4	265,107		66,277			5,251,512		1,312,878	6,564,390
3	165,809		41,452			3,284,512		821,128	4,105,639
2	100,429		25,107			1,989,396		497,349	2,486,745
1	55,878		13,970			1,106,896		276,724	1,383,620

iv. Comparison of Affordability of Renting and Owning

Figure 30 below, sourced from Table 40, compares the maximum value of property that a Q3 median household tenant can afford to rent, with the maximum value of property that a Q3 median household mortgage holder can afford to own if they buy a property outright without owning the land already, and can afford a 20% down payment, at various mortgage terms. The difference is stark: there is a consistent ratio of 2.6 between the value of property that can be rented and the value of property that a mortgage holder can afford who is paying 17.3% over 15 years with a 20% down payment. However, our calculations show that if interest rates were hypothetically reduced to 12%, and mortgage term increased to 20 years, assuming for simplicity that the mortgage rate would not affect rents and that the down payment requirement of 20% remains, the ratio of affordable rental property value to affordable mortgage would significantly reduce to 1.7. It is far more affordable to rent given current mortgage terms, but reducing mortgage interest rates and increasing the repayment period could have a large impact on reducing this.

Figure 30: Comparison of the highest value of property that a Q3 median household tenant can afford with that which holders of mortgages with a range of terms, who pay 20% down payment, can afford



If a household already owns land and seeks to use the mortgage loan amount to construct, then the mortgage does not have to be spent on the whole property but only on the cost of construction. Clearly, this means that the value of the whole property will be much greater than the value of the mortgage loan (cost of construction). However, during construction this household would have to rent a house or live elsewhere during construction until the house is ready to inhabit, a factor that presents a practical barrier to affordability.

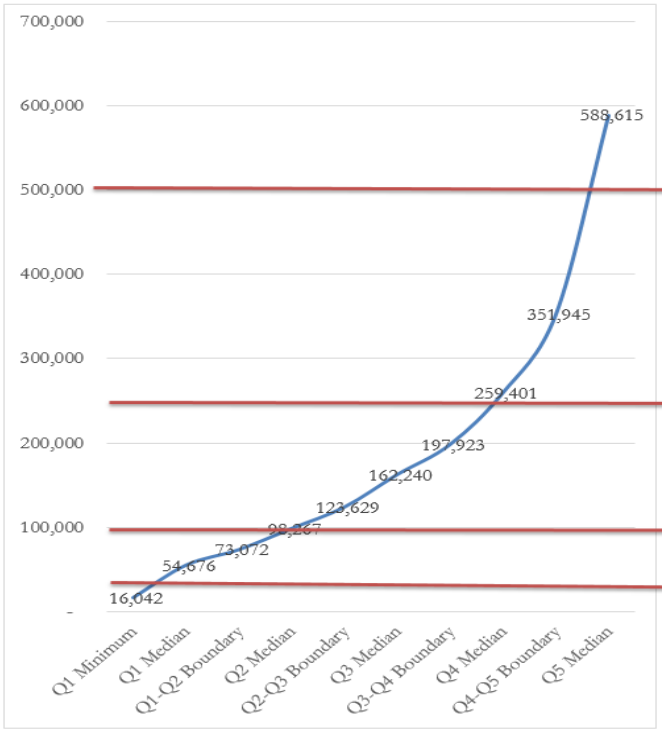
Table 40: Comparison of property value that Q3 median renters and Q3 median mortgage holders can afford, by mortgage type

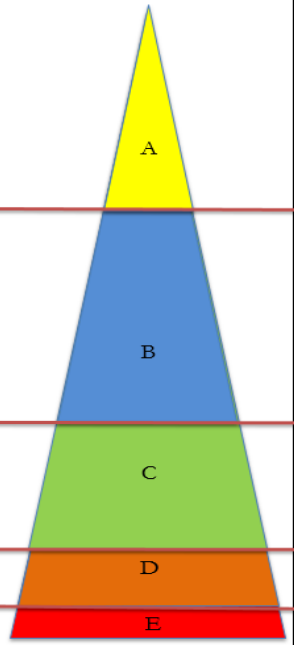
Maximum value of affordable property	Q3 median, tenant	Q3 median, mortgage for 20 years at 12%	Q3 median, mortgage for 10 years at 18%	Q3 median, mortgage for 15 years, at 17.3%	Q3 median, mortgage for 20 years at 16.5%
2018	10,272,823	6,044,850	3,306,891	4,000,152	4,504,043
2019	10,407,393	6,124,035	3,350,210	4,052,553	4,563,045
2020	10,543,726	6,204,257	3,394,096	4,105,639	4,622,819
2021	10,681,845	6,285,531	3,438,557	4,159,422	4,683,376
2022	10,821,773	6,367,869	3,483,601	4,213,908	4,744,726
2023	10,963,534	6,451,285	3,529,235	4,269,109	4,806,880
2024	11,107,152	6,535,795	3,575,466	4,325,033	4,869,849
2025	11,252,651	6,621,411	3,622,304	4,381,689	4,933,642
2026	11,400,056	6,708,149	3,669,754	4,439,087	4,998,270
2027	11,549,392	6,796,023	3,717,827	4,497,238	5,063,746
2028	11,700,685	6,885,048	3,766,529	4,556,150	5,130,079
2029	11,853,959	6,975,240	3,815,869	4,615,833	5,197,281
2030	12,009,242	7,066,613	3,865,855	4,676,299	5,265,363
2031	12,166,558	7,159,182	3,916,497	4,737,557	5,334,337
2032	12,325,935	7,252,965	3,967,801	4,799,617	5,404,215

v. Housing pyramid and analysis

Figure 31 shows the numbers of households in different monthly income categories according to the income boundaries used in the Kigali Master Plan Review. In 2017, around 13% of households earned above 500,000 RWF per month; 19% of households earned between 250,000 and 500,000 RWF; 38% earn between 100,000 RWF and 250,000 RWF, 26% earn between 40,000 and 100,000 RWF, and 5% of households earn below 40,000 RWF. We took the projected number of new households between 2017 and 2032 under medium population growth and household size scenarios, and allocated it according to the above income categories and proportions, assuming they do not change during this period. Whilst real household income growth is projected to rise, the predicted growth is slow, and it is hard to predict the actual number of additional households that will move into higher income categories. Therefore, the numbers in the table can be regarded as minimum figures. The earnings figures per month are expressed in constant 2017 prices; the nominal values of the boundaries will increase over time due to inflation. We do the same for the number of projected new houses, assuming a constant ratio of households per house of 1.2.

Figure 31: Analysis of households and housing by income category





	Total number of households in Kigali in 2017	Total new households 2017-2032	Total new houses 2017-2032
500,000+ RWF per month; 12.7% of households	44,301	47,349	39,424
250,000 - 499,999 RWF per month 18.7% of households	65,099	69,578	57,933
100,000-249,999 RWF per month 37.8% of households	131,841	140,912	117,329
40,000-99,999 RWF/month - 25.9% of households	90,140	96,342	80,218
0-39,999 RWF/month 4.9% of households	17,147	18,327	15,260

5. Policy Discussion

Rwanda is urbanising fast, from a low level of 17% according to the 2012 Census. Whilst the Vision 2020 target of 35% will not be reached by 2020, nonetheless, Kigali is growing at a rate that has led to efforts among senior policymakers to "reduce pressure" on the city[37]. It is clear that in Kigali, housing need and housing demand will increase dramatically in coming years. Satisfying that demand is important not only for the city's functioning and the well-being of the city's citizens, but will have significant implications for the country's economic growth. It follows that the planning steps taken to accommodate this demand through the provision of infrastructure and the regulations that govern housing supply are key policy measures.

According to our projections in this study, 19,000 new households were added to the city during 2018, rising to 32,000 per year by 2032, representing a need for 15,000 houses per year rising to at least 26,000 per year by 2032. This figure is not being met by the current supply of formal housing. Kigali also has a backlog of houses that would ideally be upgraded. Most households have low purchasing power and cannot afford formal housing as it is currently priced and financed, resulting in informal settlements taking up some of the supply gap. From a global perspective, this is normal for a rapidly developing and expanding country such as Rwanda, and in 17th to 19th century Europe, slums were far worse than those in today's Global South (UN Human Settlement Programme 2003). Kigali's unplanned settlements are in good condition compared to the region.

However, the escalating housing need in the face of resource scarcity presents a daunting challenge that significantly affects the welfare of the people of Kigali and the life of the city. There may be a role for publicly-funded social housing, for the lowest income groups; however, taking direct control of the issue by securing land, financing and overseeing construction to fully address the gap between housing need and supply, without focusing on households with the lowest incomes, would be prohibitively expensive and may also not have the intended result of the eradication of informal settlements. The National Housing Policy is a comprehensive document that eloquently recognises the challenges inherent in housing and the kind of approach required. An effective approach to implementing the policy must take account of the most efficient and impactful use of public money, focus primarily on public goods such as roads and other infrastructure, and respond to an accurate picture of household purchasing power, to provide an environment in which market conditions facilitate the private sector to turn this need into an economic demand for decent housing. The exception to this is the direct upgrading and provision of housing to the most vulnerable of Kigali.

Here we present a range of considerations and recommendations aiming broadly at matching supply to demand at lowest cost and at the role the government might play in this; these comments draw on this study, past IGC literature and other studies referring to regional and international experience:

- **Infrastructure will take a large amount of public investment; for cost effectiveness, it should be planned and built before housing, and might include a well-designed "sites and services" pilot:** Off-site and on-site infrastructure constitute a substantial share of the total cost of new housing developments, and will require a large amount of funding from the Government of Rwanda, as noted by Kopanyi (2015). Paul Collier has said that it is far more expensive to retrofit infrastructure after households have already invested in housing in an area. In Bogotá, the costs of regularizing informal settlements have been calculated as 2.8 times higher than the costs of developing serviced urban land for the poor (Abiko et al 2007). Changing the order (building infrastructure first) could reap potentially enormous gains by keeping Kigali one of the most liveable cities on the continent. Provision of road grids, infrastructure and transport links planned in advance of rapid peripheral expansion, are important, and should involve land pooling. One or more sites and services pilots could be combined with an incremental housing approach and should consider the important design principles highlighted in Wainer et al (2016) with respect to land, infrastructure, house architecture and building materials. Such investments should aim to lead market forces in terms of population movements and investment, rather than become wasteful, large scale projects that

[37] Senior policymakers, commenting at the IGC Industrial Policy Conference, 18th September 2018, and at MININFRA's 3rd National Urban Forum, 6th February 2019

are too far from jobs. Cost effectiveness and efficiency should be primary concerns when building road grids; cost is enormously affected by plot size as well as road and path width (Wainer et al 2016). A fascinating study by Owens et al (2018) in the influential journal World Development showed that "sites and services" investments made in in Chennai and Mumbai thirty years ago, containing varied plot sizes, densification, mixed-use layouts and strategically-selected locations for connectivity to economic activity, are now thriving communities that are inclusive, liveable and have benefited from decades of incremental household investment in improved housing.

- **An incremental approach takes time but is a financially manageable way to upgrade housing:** Urban planning should support households to develop their houses, and neighbourhoods, incrementally, most effectively in combination with a sites and services approach described in the previous point. This may be more appropriate for housing outside the Central Business District, as more central housing would ideally be built more densely in the first place. An incremental approach takes time and for some years a project may not look attractive or tidy which may be difficult politically; nonetheless, the process has worked. In the study of Chennai and Mumbai in the previous point, homeowners began with inexpensive materials but in later stages they upgraded to bricks and reinforced concrete. The principle that households can undertake incremental construction in ways that match their resources, makes the financial burden of upgrading poor quality housing manageable, but households usually need formal ownership and decent infrastructure provision to incentivise them to invest this way, and the process would benefit from incentives such as subsidies or credit (Wainer et al 2016).

- **Public money should be spent on social housing for the most vulnerable, in locations sufficiently close to jobs, but thought should go into choosing evidence-based, innovative and cost-effective ways to enhance social welfare:** The principle of providing housing for the most vulnerable is enshrined in the National Housing Policy (2015) and is a very important consideration for economic justice and fairness. It is important that any social housing is built close enough to jobs, which may mean not necessarily building on the cheapest land. However, other investments that might also be greatly welfare enhancing are pouring hard floors for the housing units that remain with dirt floors,[38] [39], or improving sanitation in the city.

- **Affordable housing should be affordable to households below the top two quintiles:** The median household in Kigali in 2020 is projected to earn around 168,000 RWF per month, or 2 million RWF per year; thus their purchasing power is limited. The poorest two quintiles, quintile two and quintile one, are projected to earn 102,000 RWF and 57,000 RWF per month respectively. Building housing units that cost more than even 10 million RWF will do little to accommodate the affordable housing shortage. In Rwanda, SKAT is implementing a Swiss government-funded project that supports the construction sector, specifically by developing clay-based building materials as an input into affordable housing. The firm built a small two-storey brick house costing 8 million RWF, and has smaller models that can be tessellated in multi-household blocks which individually may be of an appropriate cost to be economically inclusive. The danger is that if even moderately expensive units are built in numbers that are very large, and paid for by public money, the result may be under-occupancy, unprofitably low sale prices, or subsidised prices for households in higher quintiles. Building homes at low cost – and thus low market value – may be more profitable if costs can be kept down, because market demand is more likely to be assured.

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[38] There appears to have been a general decrease in houses with dirt floors in Kigali. Hitayezu, Rajashekar & Stoelinga (Forthcoming, 2018), found from data collected in 2018 that 6% of houses in informal settlements have dirt floors, and 79% have cement floors "The dynamics of unplanned settlements in the City of Kigali". Laterite and International Growth Centre, Kigali, Rwanda. EICV 4 which took place four years previously (2014), finds for the whole of Kigali that 64% have cement floors, and 31% have beaten earth floors.

[39] A World Bank study found that replacing dirt floors with concrete "significantly improves the health of young children", "leads to a 78 percent reduction in parasitic infestations, a 49 percent reduction in diarrhea, an 81 percent reduction in anemia and a 36 to 96 percent improvement in cognitive development" Accessed on 16 October 2018: http://documents.worldbank.org/curated/en/857881468288000006/Housing-health-and-happiness

As noted by Kopanyi (2015) in relation to a potential Urban Development Fund, "providing large-scale housing to the lower income household categories requires a combination of the supply- and demand-side subsidies. Any sole subsidy instrument would just narrowly broaden the affordability and would fail to reach the lower income categories"; his IGC policy note, "Supporting affordable housing in Rwanda: plans and options" expands on the options available.

- **If possible, the cost of construction should be reduced in ways that can be scaled up in the construction industry in Rwanda:** Analysis by the Centre for Affordable Housing Finance found that in Rwanda, some construction costs are cheaper than neighbouring Kenya, but professional costs and taxes tend to be high. Innovative work by SKAT on cheaper and better quality bricks that require less cement (which is expensive) during house construction, and Strawtec using alternative locally available straw, exists but these kinds of solutions need to be scaled up. Research might focus on ways to reduce costs for the construction industry as it currently is, on barriers to scaling up solutions that work and how to overcome them, on any skill gaps in the local construction industry, and on alternative, ideally locally produced construction materials and methods that both reduce cost and are more easily scaled.

- **Master Plan zoning should be flexible and respond to market conditions and should be cognizant of the effects that it can have on housing affordability:** The 2013 version of the Master Plan was criticised for enforcing regulations that make housing more expensive, such as high minimum plot sizes, large building setbacks and others. The authors' understanding is that the 2018 Master Plan Review, taking place at the time of writing, is seeking to address this with a more flexible zoning system. Zoning should be done in such a way that does not result in large numbers of otherwise acceptable houses being eradicated due to non-compliance, but allows the existence of "good enough" houses as well as allowing for ultra low cost construction at the kind of scale required. Zoning should also place the greatest number of houses as close as possible to to important public transport routes and nodes.

- **Inclusive densification should be pursued:** Whilst Master Plan zoning needs to cater for truly affordable housing, it also has to balance this with the need to zone for appropriate densification of housing close to the high value commercial nodes and transport corridors. Cities everywhere contain housing that tends to be higher in areas that are closer to the city center. This densification of buildings by "going up in height" is one of the least expensive ways to add to the supply of housing, but incrementally; building tall apartment blocks can have high construction and maintenance costs and can suffer from bad management; moreover, traditional high-rise apartments tend to promote social isolation and do not result in the interactions so important to human welfare (Montgomery 2013). Buckley (2014) recommends that a good strategy is to begin by encouraging and incentivising the families that already own single storey units to make their houses taller – ground plus two or three floors, as in Nairobi. However, international experience strongly suggests that communities should be involved, and the process should begin with situations in which current residents gain; if this process is not well managed, transformation can result in the failures seen in the US, France and Angola. Treating community members as passive recipients will increase costs and not tap their efforts as an input.

- **Housing finance should be made more affordable on a self-sustaining basis:** It will be important to find ways to reduce the high mortgage interest rate. A full discussion is beyond the scope of this paper, but solving the issue is vital to unleash the power of land collateral to fund housing. At the time of writing, the World Bank recently signed a prospective agreement with the Government of Rwanda to set up a 150 million USD revolving fund to make housing more affordable; this is a welcome development. There are several other options options for doing this. The World Bank supported one such option in Ghana almost twenty years ago, where the financial institution assigned to help the provident fund make housing finance available, the Housing Finance Company Bank, is now one of the most successful commercial banks in the country. The way funding was structured in Ghana helped maintain the financial solvency of the provident fund. The Thai government has also provided mild interest rate subsidies to redevelop low income communities, which is very effective (Buckley and Kallergis, 2014). Another option is to create a Building Society owned by members and that is thus incentivised to offer better interest rates than commercial banks;

a challenge here would be sufficient savings, but this has worked successfully in Zimbabwe, Jamaica, and 18th and 19th century Britain (Collier et al, 2017).

- **The definition of housing backlog in this study needs discussion and refinement:** If the Government is to focus on upgrading, it must prioritise: to upgrade almost half the building stock is prohibitively expensive for either the public or the private sector. Therefore the definitions provided in this study, overcrowding, low build quality, temporary homes, and homes in high risk location, should be discussed and prioritised. Possibilities include focusing on the very lowest quality buildings and allowing certain building materials that are here classed as subpar; building drains instead of replacing housing that is on steep slopes, and evaluating the definition of overcrowding here to better understand whether it may be acceptable to temporarily allow for higher densities in the short or medium run whilst recognising the need for more space per person in the long run. Relatedly to overcrowding, EICV 4 showed a mean ratio of households per house of 1.1 in 2014, up from 1 in 2011; this is a rapid increase which is not necessarily bad in the short run unless it leads to overcrowding, but nonetheless it may be worth aiming for a ratio of 1 in the long run.

- **Policymaking should be data driven:** Buckley et al (2016) note that "a precondition for fulfilling the objectives of the urban SDG goal is having better local data in order to gain a thorough understanding of the actual living and housing conditions in informal settlements." Two IGC studies respond to this need: First, "Remote sensing for measuring housing supply in Kigali" by Bachofer and Murray (2018) generated building footprint datasets in 2009 and 2015, which clearly show urbanisation trends in Kigali and contain data that is disaggregated down to the village level. Second, the IGC-funded forthcoming study, "the dynamics of unplanned settlements in Kigali, Rwanda", conducted by Laterite, responds to this to an extent by gathering data from face-to-face interviews with over 1500 respondents living in unplanned settlements in Kigali, as well as conducting SMS surveys; this study showed that SMS surveys can be successful. However, more data is always needed at the sector and cell level; this can be collected through face to face surveys, SMS, through post-umuganda discussions; often government agencies collect data that could be useful to other agencies for the purpose of housing and urban planning.

- **An Affordable Housing Working Group could be instrumental**: As noted by Kopanyi (2015), establishing an affordable housing working group "would be instrumental in leading vital policy dialogue and advising policy decisions on the overarching objectives, institutional framework, and instruments towards scaling up the affordable housing market in Rwanda".

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