Accessibility analysis of growth patterns in Buenos Aires, density, employment and spatial form

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ABSTRACT
This paper uses a lens of accessibility to examine the trends in spatial development in the Greater Buenos Aires area (GBA) over the last two decades. The analysis utilizes remote sensing data for two time periods in Buenos Aires, and auto and transit employment accessibility - calculated using an open-source accessibility tool which is being developed by the World Bank and OpenTripPlannerAnalyst (OTPA) - to analyze the spatial growth patterns. Most of the developments have occurred in the periphery of the city, which offer poor transit employment accessibility. By calculating employment accessibility of different modes in the Buenos Aires, we note that while the transit system provides high employment accessibility to the center city, as well as to the southwest and south of the city, few developments have focused in these areas. We focus on the development of different development typologies, gated communities, social housing and informal settlements, and the employment accessibility of the development locations. Utilizing this information we assess the accessibility efficiency of growth in the GBA, as well as the effective size and distribution of its labor market. We examine how spatial growth has affected accessibility for different segments of the population; draw policy implications and focus on the possible elements of an integrated regional-use transport strategy.

Keywords: accessibility, remote sensing, spatial growth, efficiency, open source, Bueno Aires
This paper uses a lens of accessibility to examine the trends in spatial development in the Greater Buenos Aries area (GBA) over the last two decades. We examine how spatial growth has affected accessibility for different segments of the population; draw policy implications and focus on the possible elements of an integrated regional-use transport strategy.

In summary we found that urban development in the GBA area over the past 20 years has been characterized by low population density, a large growing territorial coverage, and the rise of developments in the periphery of high and low income groups, without developing any urban cohesion. Transportation infrastructure has provided automobile accessibility to a larger area in the city; inducing sprawl and low-density developments in many parts of the city. The growth patterns observed indicate that most of the development is occurring in areas that provide limited transit accessibility.

By calculating employment accessibility of different modes in the Buenos Aires, we note that while the transit system provides high employment accessibility to the center city, as well as to the southwest and south of the city, few developments have focused in these areas. Most of the developments have occurred in the periphery of the city, which limits the employment opportunities accessible to residents. An inordinate share of new spatial development has been in the form of gated communities in the north of the city as well as informal settlements and subsidized housing in the western periphery, areas that provide limited transit accessibility. We utilize a comparative methodology in order to identify areas of GBA that provide high levels of accessibility, but have failed to densify, indicating areas for potentially efficient growth.

This analysis uses a combination of data sources to assess the spatial growth trends in order to initiate a dialogue with government on adequate ways to future integrate transport and land use strategy. We utilized remote sensing data for three time periods in Buenos Aires, and the calculated auto and transit employment accessibility, using an open-source accessibility tool based on a combination of publicly available data on population and employment as well as transit supply data expressed in the open GTFS format.

**METHODOLOGY & DATASOURCES**

This analysis utilizes three key inputs: remote sensing data, the city’s mobility household survey and a modal employment accessibility study of the city of Buenos Aires.

**Remote Sensing Data**

The analysis made use of remote sensing data, information derived from satellite images collected by Landsat. These images had 30 meter resolution and provided classification for built, not-built and water. As part of a larger piece of work on the urban form of the GBA area, these satellite images were available for three time periods: 1990, 2000 and 2010.

These images provided the initial information to assess the spatial growth and distribution of the city. The satellite imagery was combined with census-level information to detect areas with new developments. This work (1) classified new developments as either infill development, which occurs in already populated areas or connects two previously dense areas (densification completion); or leapfrog urbanization which indicated sprawl or discontinuous growth. This work also combined earth satellite observation data with survey data to characterize the growth into different residential typologies, including the identification of gated communities, social housing, informal settlements and slums.
Travel Patterns

The data used to determine the commuting patterns was provided by the Household Mobility Survey (Encuesta de Movilidad Domiciliaria, ENMODO) for the Buenos Aires Metropolitan Region, which included the Autonomous City of Buenos Aires and 44 surrounding municipalities. The survey, performed in 2009, included a representative sample of 22,170 households and 70,321 people. This survey was utilized to determine the commuting radiuses and modal preferences for commuting trips.(2)

Accessibility

Accessibility can be defined as "the potential of opportunities for interaction", the opportunities that are available to individuals. The understanding of accessibility that began as a simple notion of a link between transportation and land use has grown in complexity and now provides a very accurate representation of urban relations. Research at MIT by Busby(3), Warade(4) and Ducas(5) has attempted to aggregate the research done by previous scholars, determining that the key elements of accessibility are: the spatial distribution of opportunities, the mobility provided by the transportation system, the temporal constraints of individuals and activities, and the individual characteristics of people. (5)

This understanding of accessibility includes the complexities of urban mobility and transportation choices as critical factors of the accessibility of a certain region.

Transportation access influences the development of land in a certain area.(6) We expect that having an area with better accessibility encourages more development than those with lower accessibility. Travel is considered to be an intermediate good, meaning that users travel to engage in some activity or reach an opportunity. (4) Therefore, the demand for transportation alternatives is derived from the need to reach a certain location offering a specific set of services.

Transportation projects may improve the overall mobility of a city’s residents through efficiency gains, time savings, lower congestion, increased access through public transit. By providing links and access different city sectors, transportation investments may enhance access to new opportunities to many, specially the marginalized sectors of society. “Transit provides services to transportation-disadvantaged groups and fosters transport equity. It reduces the social discrepancy between the poor and the rich through mobility provision and improvement”(7)The purpose of this research was to combine the spatial analysis of growth pattern in Buenos Aires, with a deeper understanding of employment accessibility patterns. For this purpose, accessibility is defined as the number of employment opportunities that can be accessed from a given origin in a given travel time.

Building on traditional accessibility measures (3,4,5,8) the Isochrone model(9) takes into account the total number of opportunities that can be reached within a given time, distance or cost threshold. This model requires the least data calculation since it uses a standard binary (0 or 1) threshold to determine the accessible opportunities

\[ Accessibility_i = \sum_j Opportunities_j W_j \]

Where

- \( i = \text{origin} \)
- \( j = \text{destination} \)
- \( W_j = 1 \) if \( C_{ij} < C_{ij}^* \); 0 otherwise
- \( C_{ij} = \text{travel time (or cost) from } i \text{ to } j \)
- \( C_{ij}^* = \text{travel time (or cost) threshold} \)

The use of a binary threshold considers any opportunity within that threshold equally accessible, although there might be a larger impedance to travel a longer distance. This model is...
the easiest to compute but it does not include the temporal and user components of accessibility (e.g. mode preference or subset of opportunity preferences).

Accessibility for different travel modes such as auto and transit are calculated separately in order to compare the differences in accessibility that each mode provides. We do this by calculating travel times in order for each mode separately and use this time as $Cij$.

The Open Trip Planner Analyst (OTPA) engine is used to calculate the accessibilities. In recent years this approach has been used for similar accessibility analyses in US settings (10) though the authors are not aware of other applications outside of the US yet. This tool utilizes the road network (in this case OpenStreetMap), and transit attributes (specifically, a road network GIS layer and General Transit Feed Specification), to calculate the travel times from every origin-destination pair in the city. The tool then combines the estimated travel times and location data for employment opportunities (or other opportunity inputs) to calculate the accessibility value for every point in the city. This flexible open source tool provides, with ease and detailed granularity, the basis for the accessibility analysis of the city.

This work is based on accessibility indicators based exclusively on time – a combination of waiting and travel time. Ideally, elements of cost would also be incorporated into the indicator, particularly to assess accessibility for the poor. However, this is not a serious distortion in the case of Buenos Aires, where tariffs have remained highly subsidized and low cost, particularly in the period 2001-2010 and have been largely invariant to travel distances.

**MOBILITY PATTERNS IN BUENOS AIRES**

An analysis of the ENMODO data helps to illustrate how actual mobility patterns in GBA relate to the accessibility indicators developed.

The average travel time for a work trip in the GBA is almost 41 minutes, with a median of 29 minutes. Travel times are higher for lower income trip-makers: trips for those in the bottom household income quintile are on average 41.82 min long and those in the highest quintile are 39.76. The commuting travel patterns observed in the ENMODO survey(2) shows that most employment commutes take less than 60-minutes; only 22% of all commutes are larger than this. Therefore in order to perform the accessibility calculation of Greater Buenos Aires, we utilized a 60-minute travel time radius as the travel threshold.
FIGURE 1 Travel time distributions for work trips.

Public transport remains the most common means of transport for journeys in the GBA. Based on the ENMODO survey of all travel stages performed on a typical week day about half (49.0%) of the population were using public transport, this included bus (39.1%), rail (6.3%) and subway (3.7%). For low-income population (lowest household income quintile), public transport accounts for 45% of the stages of travel, while the walking mode represents 36% and 10% car. Furthermore, most people make their travel in GBA without any transfers (89%), a constant trend among all quintiles.

SPATIAL GROWTH PATTERNS IN ARGENTINA

Even a casual examination of the available data suggests that Buenos Aires experienced an unusual spurt of spatial growth in the 2000-2010 decade. During the decade of 1990-2000 the urban footprint of the metropolitan area of Buenos Aires grew at a rate of less than 1%, lower than the spatial growth of other cities in Latin America during the same period(11). During the next decade however, between 2000 and 2010 Buenos Aires grew faster, with increased rates of developments in the peripheral areas and discontinuous developments projects. The rate of urban expansion has doubled since 2000, rising from 19% to 39% in 2010. During this time population increased by 1,345,968, an 11.8% increase. Utilizing remote sensing data, we learn that much of the peripheral low-density development in the last 50 years has been caused by residential gated communities. Gated communities are characterized by low population densities, occupying vast land that disrupts the urban and environmental fabric. Socially, gated communities are segregated from the urban fabric since the closed nature of the developments limits movement or prohibits to non-residents. Most of the residents of gated communities are high income people that have a higher auto usage than the rest of the population. Between 2000 and 2010, these gated communities have increased 39 km$^2$ (18% of total zoned area for these uses). Figure 2 below shows the new gated community developments in the decade 2000-2010, which were concentrated in the northern sector of the GBA.

A large part of the increase in peripheral developments has also caused by been the increase of informal settlements and social housing in the west of the city. Informal settlements are home to 508 thousand families in the GBA(12). This population rose from 4.3% of the total population in 1981 to 6.8% in 2001 and 10.4% in 2006(13). According to the report Techo 2014, 681 informal settlements were recorded, which occupied 128.31 km$^2$ of land. A large part

### Trip Statistics for different quintiles

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Mean</th>
<th>St. Dev</th>
<th>Median</th>
<th>Trips Longer 60'</th>
</tr>
</thead>
<tbody>
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<td>All</td>
<td>40.84</td>
<td>26.15</td>
<td>29</td>
<td>21.6%</td>
</tr>
<tr>
<td>1</td>
<td>41.82</td>
<td>27.86</td>
<td>29</td>
<td>24.3%</td>
</tr>
<tr>
<td>2</td>
<td>41.41</td>
<td>26.80</td>
<td>34</td>
<td>22.9%</td>
</tr>
<tr>
<td>3</td>
<td>40.81</td>
<td>26.47</td>
<td>29</td>
<td>21.4%</td>
</tr>
<tr>
<td>4</td>
<td>40.77</td>
<td>25.85</td>
<td>29</td>
<td>21.6%</td>
</tr>
<tr>
<td>5</td>
<td>39.76</td>
<td>24.18</td>
<td>29</td>
<td>18.6%</td>
</tr>
</tbody>
</table>

Source: ENMODO 2010.
of the increase in slums has occurred in the periphery of the city, where settlements are on average 43.8km away from the city center.

Furthermore, social housing has also been largely located in the periphery of the city. Social housing policy designed by the federal government assigns provinces and municipalities the responsibility to obtain land for federally funded housing programs. The policy does not appear to be comprehensive however, as projects implemented historically in the country through FONAVI (National Housing Fund) have been located in areas that appear to have low accessibility to employment opportunities and access to basic services infrastructure.

A new housing strategy, Earth and Urban Design (Tierra y Proyecto Urbano), established by the Institute of Housing in the Province of Buenos Aires (IVPBA), aimed to increase the availability of land for public housing. The IVPBA provided additional funds-totaling 11% of the value of the home-to acquire land for social housing. Tenders were evaluated based on a number of criteria - project characteristics, soil suitability offered, viability of service provision and accessibility. Accessibility is evaluated by the proximity to auto transport infrastructure and bus services, and the location’s distance to a paved street homes linked to a main road.

However, this incentive to bring social housing closer to the city center has not been successful. Social housing has been created in the periphery of the city, focusing developments around the large automobile infrastructure developments, rather than the transit services.

![FIGURE 2 Density changes in GBA and location of new residential developments 2000-2010](image-url)
In order to analyze the accessibility implications of the growth in Buenos Aires, we explored the employment accessibility by the different modes in the area. We utilized the OTPA Accessibility tool to estimate the accessible employment opportunities that the transport network provides to each of the different parts of the city.

The tool first calculated the travel times for every origin destination point in Buenos Aires. For the auto travel times, we included the road infrastructure network of 2010, and calculated travel times using free-flow estimates of travel time differentiated by class of road. Ideally, congested road speeds would be used for peak times, and incorporating those is a next step for this analysis. In terms of public transport, the public transport supply was translated into a General Transit Feed Specification (GTFS) format. Employment opportunities were identified using census data from 2010.

Using this information the tool calculated for each residence, how many jobs would be accessible, in the determined 60 minutes, either in transit or private car. Though the tool calculates accessibility at most detailed level of data available, in this case the census tract, for ease of presentation, the results are consolidated into larger blocks using the weighted average of accessibility, based on the population of each input cell. The result allowed for a comparison of accessibility across the GBA.

The calculation of accessibility denotes the amount of employment opportunities that are within a 60 minute threshold of a specific origin, based on travel times of a specific mode. This calculation allows us to easily compare the relative accessibility of different parts of the city.

In order to better compare the ease of access of different parts of the city it is useful to calculate the ratio of accessibility by auto and transit, which highlights the relative difference of jobs that a resident can access by car compared to public transport. An area that is equally accessible by auto and transit will have a ratio of 1. Places that have greater accessibility by auto will have a ratio larger than 1, while the locations with the best transit access will have smaller

**FIGURE 3 Employment Accessibility for the GBA. Percentage accessibility compared to maximum city accessibility.**
ratios. Due to the large automobile infrastructure network, and the calculation of free flow auto travel times, none of the areas in the city had a ratio smaller than 1.

The ratio indicates the number of jobs that can be accessed using auto for every option that can be accessed by transit, given the same commute time. Therefore, an area with a ratio of 5 indicates, that with a 60minute commute, a resident will be able to reach 5 employment opportunities by car, for every one option accessible by transit. Figure 4 illustrates the ratio of accessibility (car:transit) for GBA. It is clearly evident from figures 3 and 4 that while the city is mostly auto accessible, with the center city having the highest levels of relative accessibility by public transport.

![FIGURE 4 Ratio of employment accessibility for GBA, Automobile: Public Transport](image)

The ability to calculate employment accessibility across the metropolitan area facilitates an analysis of the efficiency of the growth areas in the city and densification patterns of the city, as well as the implications for different residential typologies.

**EFFICIENT & INEFFICIENT GROWTH: GATED COMMUNITIES AND SOCIAL HOUSING**

With an understanding of accessibility in different parts of the city, we note that Buenos Aires has been growing in places with little public transport accessibility. Even from the spatial representations of the city, we can observe that the city has been densifying largely in the periphery, where the city offers worse overall accessibility, and worse transit accessibility in relation to auto accessibility. As we compare the different residential typologies in the periphery, we are able to identify large trends, such as the densification of the northern corridors of the city, which have focused on providing auto accessibility by expanding the highway capacity, but have the worst relative transit accessibility. We utilized the remote sensing data previously explored to assess the accessibility efficiency of the new developments in this time period.
a. Accessibility Ratio and location of gated communities

b. Transit accessibility and location of gated communities

FIGURE 5 Gated Communities in GBA

Yellow blocks indicate gated communities in figure 5a, which provide housing for high income people and have a stronger usage of automobile. These residences have largely located in the northern part of the city, which provides only high levels of auto accessibility but very poor access to public transport. The low transit accessibility that the areas provide disincentive the use of transit to a population mostly like has automobiles.

According to the modal split pattern previously explored low-income people in the GBA tend to rely more heavily on public transportation than the rest of the population. As such, social housing policy also tried to incentivize developments in areas with high accessibility. However, social housing has not been located in areas that offer a high level of transit employment accessibility. Social housing and informal settlements have grown mostly in inaccessible locations, limiting resident’s access to employment opportunities.

In order to formally characterize the trends, we developed a measure for the efficiency of urban growth in relation to accessibility. Combining our calculated index for accessibility and density changes, we can define the places with efficient or inefficient accessible growth.

\[
\text{Growth Efficiency} = \Delta \text{Density}_{2000,2010} \times \text{Accessibility Ratio}
\] (2)

Using this equation, we can highlight the places that have increased density, where accessibility is most efficient or inefficient. Places with inefficient growth are indicated by low levels of public transport accessibility compared to private transport and high density change. Therefore we utilize the ratio of auto/transit to display the accessibility inefficient densification; while the inverse ratio, transit/auto will highlight the areas in the city which has seen more efficient densification.

Another methodology to understand the growth efficiency of the city is Bertaud’s (14) proposed measure for the effective size of its job market. This is defined as the average number of jobs per worker accessible within a one hour commute for any collection of locations within the city. This index reflects the distribution efficiency of employment opportunities and labor forces residences in the city.
Effective Opportunity Size
\[
\sum \frac{(\text{Accessible Opportunities}_i \times \text{Population}_i)}{\sum \text{Population}_i}
\]

The Bertaud measure was calculated for every location \(i\) using the accessibility tool of OTPA as shown in Figure 9b. Job access measures were computed for each census block and aggregated to a region using a population-weighted average. This implementation is a generalized approach for calculating effective opportunity size for a given spatial variable. Travel times are calculated by OTPA from OpenStreetMap and GTFS data sets. In this example times are limited 60 minutes of combined travel walking and on transit. Because GTFS data was not available for Buenos Aires using an approximate GTFS data set derived from a regional transportation model.

**Figure 6 Efficiency of growth and spatial patterns in GBA**

We can normalize the Bertaud measure by the total number of jobs in the GBA (approximately 5.8 million) in order to estimate the effective size of the labor opportunities accessible to a resident. From this calculation we estimate that then effective opportunity size in municipalities range from 0.65% to 48.77% of all jobs in GBA.

Both of these calculations, looking at efficient densification and size of the labor opportunities, highlight the overall efficiency of the city center. This reinforces the need to densify the areas near the city center, which has seen low residential growth in the previous years. The first calculation highlights the accessibility efficiency of the density changes in the last 10 years (Figure 6a), while the Bertaud measure calculates the current efficiency of the labor market (Figure 6b). Therefore, we note that although some areas have had large increases in density such as the Matanza province, to the southwest of the center city, the area still lags behind in providing effective labor opportunities.

**FINDING AREAS FOR EFFICIENT URBAN DENSIFICATION**

We can use the density and accessibility information to find areas in the city that have not densified intensely, yet still offer high levels of transit accessibility. If we were to consider a
more efficient, sustainable and equitable regional planning approach (looking at GBA instead of just Buenos Aires city proper) developments should be encouraged in these areas.

Potential areas for growth will be indicated by areas that had low-density levels in 2010, and provided high levels of accessibility, relative to the auto accessibility, or relative to the other parts of the city. To calculate the relative potential for efficient urbanization, of different part of the city we used a function of the density levels in 2010 and the auto and transit accessibility. Our aim was to find potential growth opportunities, rather than to quantify a specific indicator of efficient density potential.

To highlight these areas, we calculated the potential using two indices of accessibility. An initial calculation utilized the ratio of transit accessibility to auto accessibility, and another that calculated the percentage of job opportunities accessible by transit, relative to the most accessible area in the city. The results for both calculations area displayed below.

**FIGURE 7** Quintile priority ranking for potential growth areas

Both of these calculations highlight the center city effectiveness of density creation in the city center. This reinforces the need to densify the areas near the city center, which has seen low residential growth in the previous years. Furthermore, the calculations also highlight specific locations in the immediate periphery of the city, as well as the southern part of the city. High-income residential should be incentivized where the city offers the good transit accessibility compared to auto (Figure 7a), while low income developments and social housing should be prioritized in areas the offer higher transit accessibility (Figure 7b), since low income residents are likely to be captive to transit services. These areas show the potential for growing, increasing density and providing residents good transit accessibility to employment areas around the city.

**BOX 1: Analyzing developments using detailed accessibility**

Once we have identified the larger regions that offer high accessibility and low density, we are able to utilize the accessibility tool created by the World Bank and OTPA to have a more detailed understanding of the accessibility patterns. This tool allows the user to compute the accessibility indices at a very granular level. This allows us to explore, at the point and block level the accessibility of different communities and developments. As an example, the gated community in the figure below has access to 4,913,981 employment opportunities in a one hour commute by car, and 1,050,615 in a one hour commute by transit (a 4.68 auto to transit
accessibility ratio. This level of detail provided allows a policy maker or developer to prioritize transit accessible areas for future development.

a. Transit Accessibility

b. Auto Accessibility

FIGURE 8 Detailed transit and auto accessibility of a specific development

FINDINGS: SPATIAL GROWTH AND ACCESSIBILITY

Urban development in the GBA area over the past 20 years has been characterized by low population density, a large territorial coverage, and the rise of developments of high and low income group groups (i.e., no middle income groups) in the periphery. Development typologies have been mostly gated communities, slums and social housing projects, that have failed to create urban cohesion. This pattern of development has impacted the utility infrastructure (roads, water, sewer, and electricity): causing high travel times for residents and poor sanitation infrastructure coverage.

Transportation infrastructure investments have been a major driver of the spatial growth of GBA. A first period of urban growth, was led by expansion of the railway network, which facilitated the access to a larger part of the city. After 1980 however, the construction and expansion of many of the highways connecting the periphery of the GBA with the city center, along with policies that encouraged the purchase and use of the car lead to the sprawl of the urban areas, led to a decrease in city density. The expansion and improvement of highways in the GBA, and subsequent suburban growth led to an improvement of the auto accessibility to a larger part of the urban area and an exponential increase in demand of automobiles.

The low density pattern of growth in the area decreased the feasibility of using non-motorized modes of transport (bicycles, walking). Thus, it increases the dependence on motorized transport, travel times and external costs, including congestion, air pollution and emission of greenhouse gases.

The analysis showed that the city has been growing inefficiently from a transit accessibility point of view. Gated communities are creating low-density development in areas with low transit accessibility, which increases the resident’s dependency on auto commute. Similarly, social housing and informal settlements, whose residents are low-income people, highly dependent on transit, are located in areas that offer limited transit accessibility relative to auto accessibility.

The changes in growth and accessibility show that the city has grown largely in areas that offer poor transit employment accessibility.
CONCLUSIONS

From a technical point of view, we note that:

- The combination of remote sensing and accessibility analysis provide a new lens with which to explore the complexity of the relationship between transportation and land use patterns. At the high level, an analysis of mobility patterns confirms that most commuting trips do conform with the accessibility indicator used; i.e. are less than 60 minutes in duration.

- Aggregate indicators such as the proposed growth efficiency indicator or Bertaud’s effective size of its job market allows us to monitor the evolution of the urban spatial structure and compare different spatial distributions and the accessibility efficiency of the urban shape.

From our more detailed understanding of the growth patterns of the city, we note that the city has grown inefficiently, low density patterns in the periphery which have limited transit accessibility to employment opportunities when compared to the auto. Gated communities do not offer high-income residents high transit accessibility, reinforcing their auto dependency. Low-income people living in informal settlements, highly dependent on transit, are located in areas with limited transit access relative to auto, which limits their employment opportunities.

Furthermore social housing is not being efficiently located in areas that offer its transit-dependent residents high employment accessibility.

These tools allow us to better understand the regional trends of growth development and regional accessibility. Given this comprehensive understanding, we are able to make the following policy recommendations:

- If we are to consider a regional approach to land use planning, this methodology indicates that there are a number of areas, closer to the center city, as well as the south of the center city, which provide high transit accessibility but are not yet densely populated.

- Accessibility is a product of the spatial distribution of residents and opportunities, as well as the transportation infrastructure and network. Therefore, we can also improve the transit accessibility of low density areas in the north and west of the city, where we have seen inefficient growth patterns, by improving the transit services and reducing travel time to the center of the city.

Utilizing the lens of accessibility, we are able to provide more insight on the spatial development trends in the GBA. This analysis helps to frame questions for a deeper analysis of land use and the spatial development of BA, which addresses the causes of such a growth in gated communities and informal housing. Questions such as why the market is not producing more development where accessibility is higher and what policy reactions (if any) can support a more accessible pattern of spatial development still need to be further explored.

The accessibility analysis presented here cannot answer those questions fully – but it informs the larger conversation on the spatial development of GBA. Indeed, in this case, this accessibility analysis has been used precisely to focus such a deep dive into land use and transport. This analysis is ongoing and results will be available imminently.

ACKNOWLEDGMENTS

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