‘DE ALUGUNA MANERA, LLEGAS’:
A GEOGRAPHIC INFORMATION SYSTEMS STUDY OF
PUBLIC TRANSIT ACCESSIBILITY FOR
PRECARIOUS SETTLEMENTS IN
BUENOS AIRES, ARGENTINA

by

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STATEMENT BY AUTHOR

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Abstract

Popularly known for tango halls, wide avenues, football stadiums, and Parisian architecture, the urban landscape of Buenos Aires, Argentina is, in fact, increasingly marked by dramatic examples of socioeconomic inequality. Over 1.2 million of its 13 million inhabitants live in informal housing communities, where the provision of essential services is inadequate. Perhaps a reason Buenos Aires is not more commonly associated with images of these types of settlements, especially given their relative size, is that most are what are known locally as *asentamientos*. Somewhat unique to Buenos Aires, these are informal settlements defined by their locations in the metro area's suburban periphery, far from its cosmopolitan core. A growing topic of interest to academics and non-profits in Argentina, who have tentatively shown *asentamientos* to lack access to critical services like electricity, potable water, sewerage, and paved streets, there is much that still needs to be known about them. One service whose provision has not yet been well explored in relation to the *asentamientos* is public transportation.

Unable to afford private automobiles, the low-income residents who typically inhabit Buenos Aires' *asentamientos* are entirely reliant on public transportation to access employment, schooling, healthcare, and other urban amenities. If transport services are inadequately or inequitably provided to the *asentamientos*, as is suspected by local researchers and NGOs, they are at risk of unemployment and other forms of social isolation. Seeking to identify, and therefore circumvent, these consequences, this thesis employs transit schedule data from Google Maps to calculate whether there are significant disparities in transit-facilitated accessibility between Buenos Aires' *asentamientos* and its formal neighborhoods. Access is measured from a sample of *asentamientos* from different parts of the metro area—representing regions at different

stages of urbanization—and calculated to a set of quotidian amenities, e.g., central business districts, schools, healthcare, and railway stations. It is ultimately shown that the *asentamientos* are indeed characterized by longer transit-facilitated travel times to most destinations, with the largest disparities in fully-urbanized parts of the conurbation.

Chapter 1: Introduction

Because of their quotidian nature, urban transportation systems have an indisputably vital role in contemporary human society. Without transportation, it would be impossible for people to reach essential daily sites of employment, education, public services, healthcare, recreation, and family (Cervero, 2011; Guzman, et al., 2017). In fact, transport's role as a facilitator of accessibility is perhaps its most important function. Transportation services, modes, and infrastructures are the means for people to traverse distances and reach strategic activity sites and, in an ideal setting, they play this role equitably, ensuring that all people—regardless of their socioeconomic background or location—can access any other destination within a metro area within a reasonable amount of time or cost.

Equitable transportation services in a metropolitan area are rarely found because accessibility levels vary throughout the territory of a city or region. The transportation system—and its many components, public and private—prevents, or even impedes, some members of the public from affordably making trips across the landscape while sanctioning, and even promoting, mobility for others. For those belonging to the former group, poor accessibility can have deleterious consequences: social isolation, underemployment, poverty, worsened health, and poor education. When transportation links are suboptimal—whether measured by financial cost, time, discomfort, or insecurity—people are at risk of exclusion from full participation in urban life.

Concerns about the negative impacts of a substandard transportation system on accessibility are most acute when those burdens overwhelmingly disadvantage marginalized groups of people, like the poor, women, racial minorities, and the disabled. For some of the most mobility-limited people in a society, publicly-available transportation services are often the only link between these groups and the benefits that come with participation in city-life. Oftentimes these links are ignored or neglected by authorities, especially when marginalized groups lack the meaningful political representation needed to shape transit policy in the face of stronger, more influential mobility interests. Such concerns have been noted, as evidenced by their inclusion as a United Nations sustainable development goal for the provision of “access to safe, affordable, accessible, and sustainable transport systems for all … notably by expanding public transport, with special attention to the needs of those in vulnerable situations (11.2).”[1] Studying public transport inequalities can help produce policies and planning strategies that contribute to such a goal.

Buenos Aires, Argentina—the focus of this study—is one of many cities where concerns about transportation, accessibility, and inequality are omnipresent. As with many other cities in the Global South, where transport “conditions remain highly inadequate for most of the population … [with] low accessibility, poor public transport supply, accidents, discomfort, pollution, and congestion,” metropolitan Buenos Aires’ territorial landscape is marked by inequalities related to income, housing, education, transportation, and *access* (Vasconcellos 2001). Perhaps no better illustration of this characteristic are the hundreds of informal, precarious settlements found in its urban periphery. Known as *asentamientos*, they are illegal communities settled by low-income families, situated in isolated, environmentally-precarious locations, and that lack access to most common services, like plumbing, electricity, sewerage, and—as is widely suspected but not as visibly evident—transportation.

[1] https://sustainabledevelopment.un.org/sdgs

Emblematic of structural inequalities that plague Latin American cities, the *asentamientos* represent the struggle for access to the city faced by marginalized peoples, especially in the face of a substandard offering of transportation services. Originally founded as communal refuges for families forcibly evicted from the shantytowns of Buenos Aires' urban center, they exist on whatever land their residents found available. Oftentimes they are situated along riverbanks or other undesirable tracts of land in the city's suburban fringes: peripheral locations innately isolated from the region's highly-developed core. Public transportation services, deteriorated by decades of mismanagement and characterized by services inefficiencies, have not followed the movements of the marginalized out to the *asentamientos*, leading many to speculate that the *accessibility* of Buenos Aires' *asentados* is being inhibited by a dearth of effective mobility options. That the wealthier, "motorized" classes of metropolitan Buenos Aires have seen great improvements in the speed and cost of their mobility conditions during the same time period only exacerbates concerns about suspected inequalities.

No existing study specifically documents the existence of inequalities of access between the *asentamientos* and their surroundings. The purpose of this paper, therefore, is to quantify the *accessibility* levels of these communities—vis-à-vis the regional public transportation network—and illustrate the degree to which these inequalities exist. As such, I seek to answer the following questions:

- **Within metropolitan Buenos Aires, do the *asentamientos* enjoy worse public transit-facilitated access to important activity sites (e.g., employment sites, public health care, public schools), measured in travel time, than other parts of the conurbation?**
- **In turn, does accessibility vary across the conurbation and those departments characterized by different degrees of urbanization (e.g., totally urban, mostly urban, and partially urban)?**

This study is a direct answer to a series of calls made by geographer David Keeling, an expert on transportation systems in Latin American and Buenos Aires, who believes that, "Latin America should offer fertile ground for studies of accessibility, mobility, infrastructure, and transport policies... [and] more research is needed on accessibility and mobility in megacities like... Mexico City, Sao Paulo, and *Buenos Aires*" [emphasis added] (2008, pg. 103-104). He also beseeches researchers to consider similar questions from across the region: spatial mismatches in the supply and demand for infrastructure and accessibility services, the socio-economic and political origins and impacts of projects, the spatial impacts of transportation infrastructure, and the livelihoods of people living in the precarious informal communities on the peripheries of all major Latin American cities (2002, 2008, 2013).

Beyond these thematic considerations, I also answer a methodological call of Keeling's (2008): for a greater incorporation of GIS and mixed-methods approaches into Latin American-based transit research. Among this paper's primary contributions is its incorporation of new travel time data into a GIS study. I used Google's Distance Matrix API (Application Programming Interface) web tool to query its servers and obtain estimates of transit-travel times within Buenos Aires. This novel approach relies on Google's recently-digitized archive of transit schedules from across the metro area.

Realistic estimations of travel times for trips made using public transportation, calculated with Google data, permit an unprecedented operationalization of *accessibility* in the Buenos Aires context. Rather than considering access as simply a factor of distance, the role of time, which is far more impactful on individual access to destinations, can be studied. The adoption of these methods additionally helps to fulfill one other request: that results be provided to governments and planning agencies, raising awareness of any problems of suboptimal transit-facilitated accessibility in their communities. By selecting a simplistic, easily-understood accessibility metric (i.e., the minimum time between each community and its nearest opportunity sites), this paper can hopefully provide useful information to policy-makers and community members.

In the subsequent chapters, I present the background, history, literature review, methods, results, and conclusions of my study. I begin in **Chapter 2** with an overview of the study area and the political geography of Buenos Aires' metropolitan region, followed by an overview of the region's transportation system in **Chapter 3**. These are complemented by **Chapter 4**, which contains a history of the *asentamientos* in Buenos Aires and an illustration of contemporary housing and transportation conditions in the conurbation. These introductory chapters together show how Buenos Aires' socio-territorial configuration is the result of decades of political decisions (and indecisions) regarding housing, mobility, land use, and urban development. The following section, **Chapter 5**, summarizes the literature on *accessibility*, including its definition, operationalization, and policy relevance. **Chapter 6** subsequently outlines the project's methods, which include the application of the Google Distance Matrix API web tool for calculating transit-based travel times. After discussing the statistical tests that I performed on these data, **Chapter 7** contains results, contextualized to Buenos Aires' urban geography. Finally, in **Chapter 8**, concluding remarks are provided on the state of transit-facilitated accessibility in the *asentamientos* of Buenos Aires with suggestions for future research.

Chapter 2: Political Geography of Metropolitan Buenos Aires

Buenos Aires is the capital and largest city of the Republic of Argentina, a country of over thirty-three million people at the bottom end of South America. The original port site of Buenos Aires lies on the shores of the Rio de la Plata, a large estuary on the country's eastern coast. Now one of the largest urban areas in Latin America, over a third of Argentina's total national population—ca. 13 million people--live within the Buenos Aires conurbation (Blanco and Apaolaza 2018). Sprawling outward from the city's historic center and port, five-hundred years of development has produced a massive, dynamic metropolitan region that extends nearly one-hundred kilometers in all landward directions across the flat topography of coastal Argentina.

Figure 2.1: Map of the Republic of Argentina highlighting the Province of Buenos Aires and the Autonomous City of Buenos Aires

Originally a coastal mercantile town built on the processing and export of crops and minerals from the country's interior, Buenos Aires is now a major global city linking the southern region of Latin America to the world economy and accounts for half of Argentina's national GDP. While its fortunes and economic well-being have waxed and waned over the centuries, it has attracted a continuous flow of migrants, whether from the Argentine hinterland, the European mainland, or its South American neighbors, seeking employment and an increased quality of life (Keeling 1996). Many who have come to the region have been forced to settle in Greater Buenos Aires' informal suburban neighborhoods—known as *asentamientos*—and it is these residents' search for a better life that motivates this thesis, with its focus on how the peripheral locations of such settlements may be under-served by the region's massive public transit system.

Before delving into the history and geography of Buenos Aires' informal housing communities and its public transportation network, I will begin by defining the spatial unit of analysis for this project: Agglomerated Buenos Aires. Agglomerated Buenos Aires, or the *Aglomerado de Buenos Aires (hereafter AGBA),* as it is known in Spanish, is the technical name for the geographic area occupied by each of the administrative districts that the Argentine census authority (*Instituto Nacional de Estadistica y Censos*—National Statistics and Census Institute or *INDEC*) has deemed part of the metropolitan area surrounding the centrally-located City of Buenos Aires (Gemini 2003). AGBA is designated to include the Autonomous City of Buenos Aires (*Ciudad Autonoma de Buenos Aires* – hereafter CABA), which anchors the entire conurbation, and thirty-two adjoining departments of the adjacent *Province of Buenos Aires* (shown on **Figures 2.1** and **2.2**). Together these departments form a large ring to the northwest, west, southwest and southeast of the City, as seen on **Figure 2.3**.

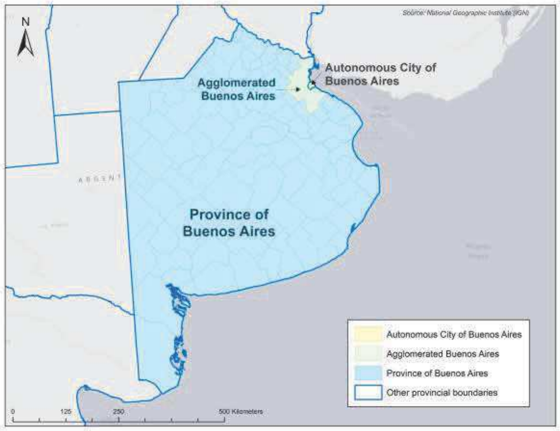

Figure 2.2: Map of the Province of Buenos Aires, showing the relative location of the Autonomous City of Buenos Aires (CABA) and the surrounding conurbation

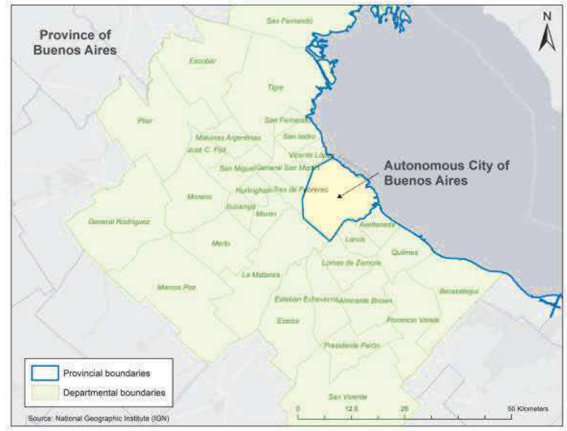

Figure 2.3: Map of the departments belonging to Agglomerated Buenos Aires, which encircle CABA

While CABA is fairly small and bears the formal title of "City," it operates politically as a province (the first-level administrative level in Argentina). It is an independent entity, with its own mayor and legislature. The similarly-named *Province of Buenos Aires* does not actually govern its namesake city and, furthermore, has its own capital and legislature in the city of La Plata, sixty-kilometers southeast of CABA. As with any other province in Argentina, the Province of Buenos Aires is divided into a series of second-level administrative areas known as *departamentos* (hereafter departments, shown as blue polygons on **Figure 2.2**), several dozen of which are located within CABA's suburban sphere. While many of these departments are similar in area to CABA (see **Figure 2.3**), they are governed by the provincial legislature in La Plata and possess little political autonomy. Lastly, it must also be noted that the federal government of Argentina (including the presidential palace, the legislature, and all bureaucratic headquarters) is based within CABA. As will be discussed later, these political-administrative distinctions, especially between province and department, have been immensely important in shaping transport planning and housing policy in AGBA.

To manage the confusion regarding administrative areas, INDEC devised a classification scheme for determining which departments belong to the metro area (as well as providing this collection of political units with a name). They started by noting that the historic way of defining the provincial departments encompassing Buenos Aires' suburban sprawl has been Greater Buenos Aires (*Gran Buenos Aires* or GABA)—an area that includes CABA and the twenty-four adjacent departments within the province: Almirante Brown, Avellaneda, Berazategui, Esteban Echeverría, Ezeiza, Florencio Varela, General San Martín, Hurlingham, Ituzaingó, José C. Paz, La Matanza, Lanús, Lomas de Zamora, Malvinas Argentinas, Merlo, Moreno, Morón, Quilmes, San Fernando, San Isidro, San Miguel, Tigre, Tres de Febrero, and Vicente López. Greater Buenos Aires, however, is only a descriptive term; there has never been a formal administrative unit or governmental body encompassing all these districts together. As will be shown, those departments that comprise GABA have the strongest historic, social, and commercial ties to the City.

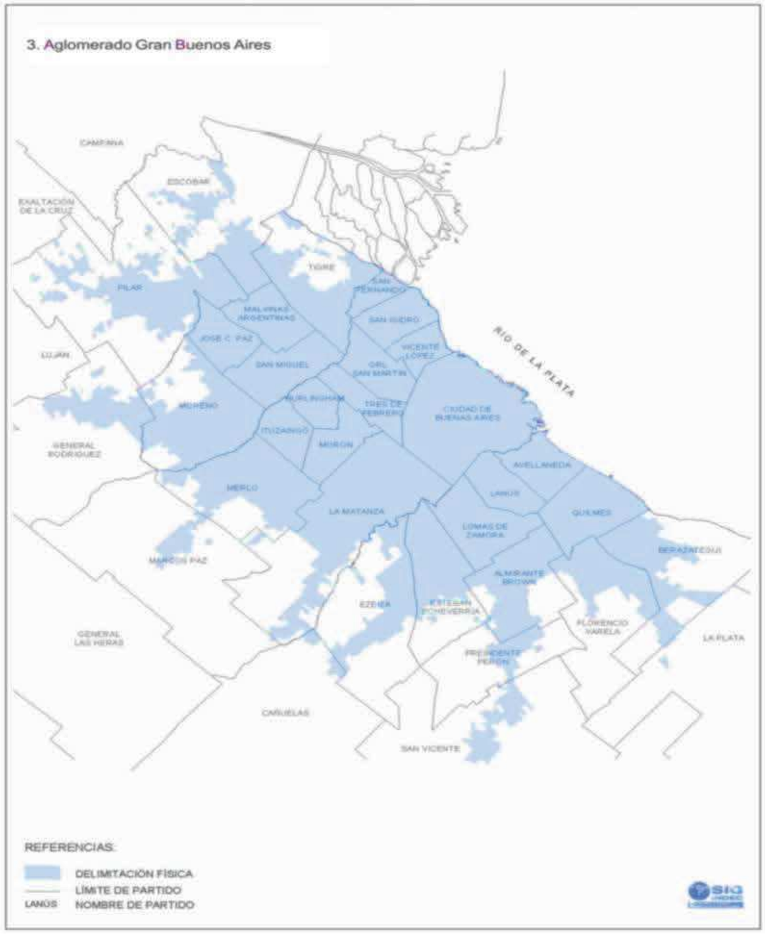

Figure 2.4: The full extent of Buenos Aires' agglomerated area, with departmental boundaries superimposed (Gemini 2003)

Further adding to the morphological complexity, INDEC statisticians also note that the continuous urbanized surface of the conurbation (referred to as the metropolitan area's "urban sprawl", "population envelope", or "agglomeration) does not entirely conform to these districts' boundaries. As such, an alternative definition of the region is required. Shown in blue on **Figure 2.4**, INDEC classifies this area—termed *Agglomerated Buenos Aires (AGBA)*—as the full spatial extent of all urban housing and development emanating outward from CABA, a boundary that is continuously shifting outward as new land is developed at its periphery. It is likely more extensive now than when this definition was set down in 2003. As will be discussed, most of these outlying areas were incorporated into Buenos Aires' socio-economic sphere through the expansion of its railroads and, eventually, highways. These modes allowed goods and, increasingly, people to move into and out of the urban core. Over time, suburban developments filled in vacant land in the departments immediately adjacent to CABA and then sprawled outward as people continued to migrate into and within the region (Gemini 2003).

Referring back to **Figure 2.4**, it is clear that AGBA's territory does not spatially cohere to any existing administrative boundaries. It overlaps fourteen districts, entirely, and eighteen partially (although two of these—Cañuelas and La Plata—have only a very minor intersection). In turn, INDEC decided to use the extent of individual departments' overlap with AGBA—alongside their historical status as part of greater Buenos Aires—to devise a classification scheme to differentiate them from one another. These categories are mapped onto **Figure 2.5**,

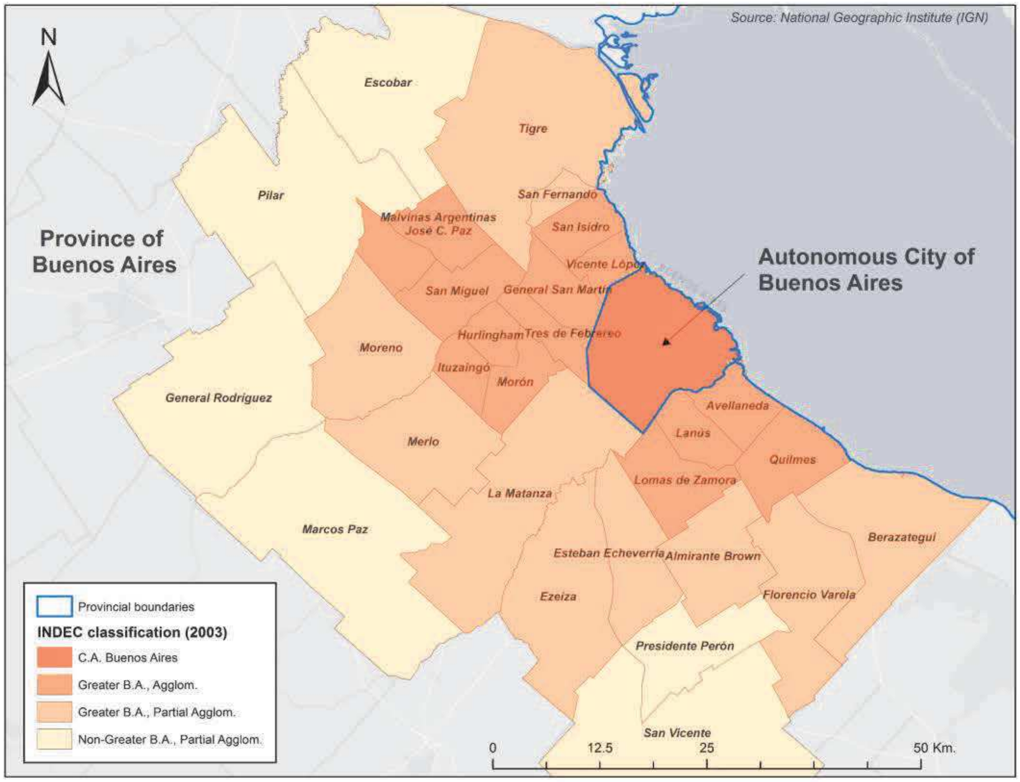

Figure 2.5: Departments of Agglomerated Buenos Aires (AGBA), color-coded based on degree of urbanization and history as part of Greater Buenos Aires (GABA)

The three grand categories are: (a) those considered part of GABA and totally agglomerated, (b) those part of GABA but only partially agglomerated, and (c) those outside of GABA but overlapping substantially with the agglomerated surface (from **Figure 2.4**) of Buenos Aires. **Table 2.1** contains summary statistics for these three categories and their constituent departments, with values taken from Argentina's most recent (2010) census. The differences between these administrative units, and their degree of "urbanization" or "agglomeration", are salient to the histories of transport and housing in metropolitan Buenos Aires, the project methodology, and this thesis' results.

Table 2.1: Summary statistics for the departments of Agglomerated Buenos Aires (AGBA) and the INDEC agglomeration categories (2010)

Department	Population (2010)	% of AGBA Population	Area (km²)	% of AGBA Area	People per km²	Agglom., Classification (2003)
C.A. Buenos Aires	**2,890,151**	**21.6%**	**204.1**	**3.87%**	**14,051**	CABA
Lomas de Zamora	616,279	4.8%	88.6	1.68%	7,037	GABA, Totally Agglomerated
Quilmes	582,943	4.3%	91.9	1.74%	6,365	
Lanús	459,263	3.4%	50.2	0.95%	8,962	
General San Martín	414,196	3.1%	56.3	1.07%	7,355	
Avellaneda	324,677	2.6%	57.0	1.08%	6,089	
Tres de Febrero	340,071	2.5%	45.4	0.86%	7,444	
Malvinas Argentinas	322,375	2.4%	63.0	1.20%	5,114	
Morón	321,109	2.4%	55.3	1.05%	5,805	
San Isidro	292,878	2.2%	52.2	0.99%	5,604	
San Miguel	276,190	2.1%	83.5	1.58%	3,337	
Vicente López	269,420	2.0%	34.5	0.65%	7,794	
José C. Paz	265,981	2.0%	50.2	0.95%	5,306	
Hurlingham	181,241	1.4%	34.9	0.66%	5,123	
Ituzaingó	167,824	1.3%	38.1	0.72%	4,407	
Zone 1	**4,852,447**	**36.1%**	**596.9**	**12.20%**	**8,129**	
CABA and Zone 1	**7,742,598**	**57.6%**	**801.0**	**19.07%**	**9,666**	
La Matanza	1,775,816	13.2%	327.9	6.22%	5,432	GABA. Partially Agglomerated
Almirante Brown	552,902	4.1%	129.0	2.45%	4,273	
Merlo	528,494	3.9%	174.5	3.31%	3,039	
Moreno	452,505	3.4%	185.5	3.52%	2,432	
Florencio Varela	426,005	3.2%	189.7	3.60%	2,245	
Tigre	376,381	2.8%	396.2	7.52%	954	
Berazategui	324,344	2.4%	220.1	4.18%	1,474	
Esteban Echeverría	300,959	2.2%	121.4	2.30%	2,481	
Ezeiza	163,722	1.2%	237.1	4.50%	689	
San Fernando	163,240	1.2%	24.4	0.46%	6,687	
Zone 2	**5,064,368**	**37.6%**	**2,005.9**	**38.06%**	**2,525**	
Greater Buenos Aires	**12,806,966**	**95.2%**	**3,010.9**	**57.13%**	**4,254**	
Pilar	232,463	1.7%	385.6	7.32%	603	Non-GABA, Partially Agglomerated
Escobar	178,155	1.3%	302.0	5.73%	590	
General Rodríguez	87,491	0.7%	367.4	6.97%	238	
Presidente Perón	60,191	0.5%	120.4	2.29%	500	
San Vicente	44,529	0.3%	658.7	12.50%	68	
Marcos Paz	43,400	0.3%	425.8	8.08%	102	
Zone 3	**616,229**	**4.8%**	**2,259.9**	**42.88%**	**273**	
Agglomerated Buenos Aires	**13,453,195**	**100.0%**	**5,270.8**	**100.0%**	**2,552**	

Sources: Instituto Nacional de Estadísticas y Censos (2010); Gemini (2003)

Additional datasets published by the Argentine federal government, including the *2010 National Census of Population, Households, and Housing* (from INDEC) and commuting data produced by the Ministry of Transport, disclose some additional pertinent information about the departments that comprise AGBA (Instituto Nacional de Estadísticas y Censos 2010). Looking first at population totals, the departments with the largest populations are those immediately surrounding CABA. La Matanza, Lomas de Zamora, Almirante Brown, and Quilmes. These are all departments classified as "entirely" or "mostly" urban; many of the least-populated are those located in AMBA's suburban periphery and among those areas not traditionally considered part of Greater Buenos Aires: San Fernando, General Rodríguez, and Presidente Perón.

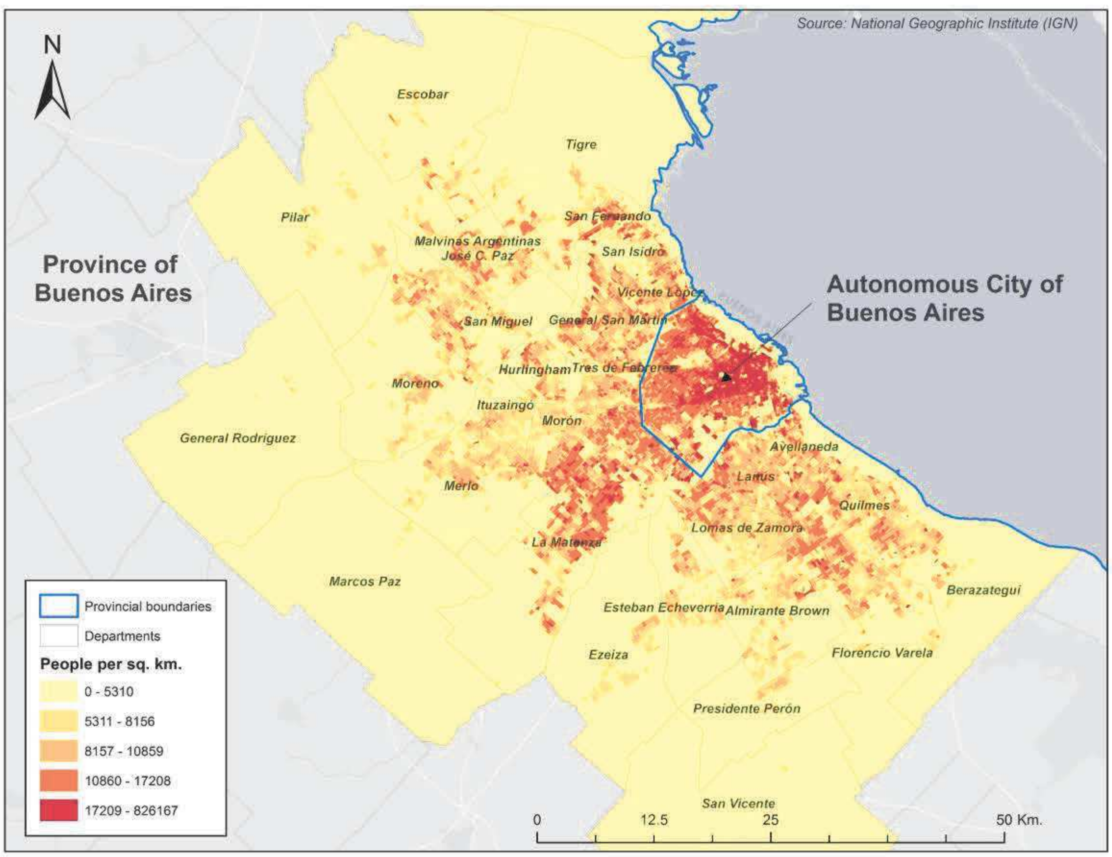

Figure 2.6: Population density, measured in people per square kilometer, across the departments of Agglomerated Buenos Aires (AGBA)

Figure 2.6 gives a substantially finer-grained perspective on the region's settlement geography, showing patterns of population density across AGBA's thirty departments. The highest densities are almost entirely within CABA's boundaries, with axes of higher densities spreading out in different directions from the core. The lowest densities, meanwhile, are found in AGBA's outermost departments (many of which possess substantial agricultural lands) and along the edge of the Rio de la Plata. Together, these patterns illustrate a predominant historical characteristic of metropolitan Buenos Aires: high central densities that gradually decrease as one travels outward into the periphery. Any pockets of density outside of CABA are found along the city's commuter railway lines (Blanco 2014; Van Gelder, et al. 2016). As will be explained below, the proliferation of the automobile during recent decades is changing this arrangement.

The spatial distribution of socio-economic development patterns in the conurbation is like that of population density. According to Blanco and Apaolaza (2018), "throughout its history, and in line with its Iberian colonial past, the central area of the city has maintained high material and symbolic value, evidenced in the residential predominance of the wealthier and more prestigious classes (pg. 3)." The inhabitants of the present-day federal district have long been wealthier than their suburban counterparts; the neighborhoods on CABA's northern side are some of its most luxurious. Looking beyond the boundaries of the federal capital, however, reveals a continuation of this north-south wealth gradient. Since the nineteenth century, the region's upper classes have lived on its northern side—both within the city and within the adjoining departments—while working and middle class *porteños* (the colloquial nickname for people from the

City of Buenos Aires) have called the southern and western neighborhoods (traditional centers of shipping and manufacturing) home (Van Gelder et al. 2016). Consequently, housing informality patterns follow this trend.

Unfortunately, neither INDEC nor any other Argentine government agency publishes any spatial data that can be used to directly map these patterns. INDEC does, however, publish a wide variety of other datasets related to demographics, household characteristics, and housing quality that serve as proxies for income (INDEC 2010). For instance, **Figures 2.7a-b** show illiteracy (inversely-related to income) and university-education (positively related), respectively. While there are certainly pockets of "poverty" in just about every department, we can clearly see how illiteracy rates are much higher in the periphery than in the core. Furthermore, many of the lowest rates are along the conurbation's northern flank and immediately along transportation corridors, including those districts in the far north found along the motorways leading into the city. Some of the worst values for both metrics are in those zones farthest from the central business district, outside of GABA, and in the spaces between railroad lines and highways (Blanco and Apaolaza, 2018; Guerra, et al. 2018). The splotches of university-educated people in the suburbs are linked to the rapid growth of upper- and middle-class gated suburbs over the past several decades.

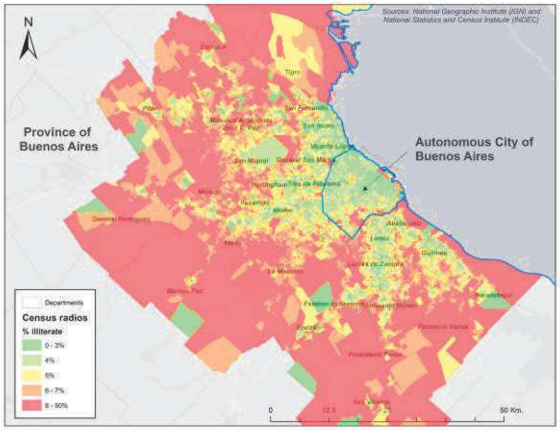

Figure 2.7a: Illiteracy rates in Agglomerated Buenos Aires (AGBA), 2010

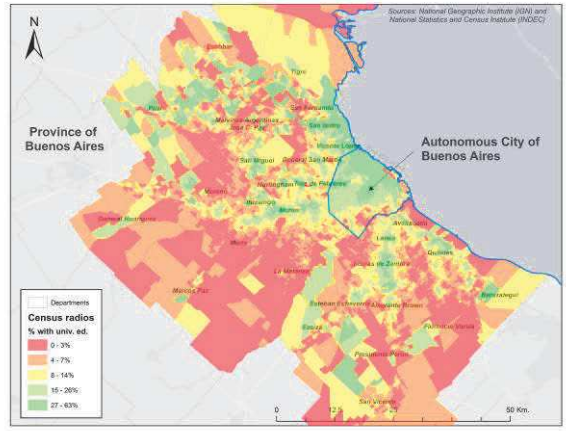

Figure 2.7b: University-level education rates in Agglomerated Buenos Aires (AGBA), 2010

In 2009, the Ministry of Transportation carried out a survey—known as the Metropolitan Mobility Survey (hereafter referred to by its Spanish initialism, *ENMODO)* that surveyed 22,170 households from across AGBA. Alongside its main goal of providing data on mobility, origins/destinations, and modal preference within the conurbation, ENMODO also gave a snapshot of regional socioeconomic trends (Secretaría de Transporte 2011). For instance, 44% of people are employed, with the majority (87%) in the private sector, 27% are students (two-thirds in public schools), and 12% are retired. In terms of schooling, more than half of all AGBA residents have, at most, a secondary-level education. 25.8% have either no education or have only partially completed primary school while just 5.7% have anything above university-level.

Because ENMODO data will be heavily relied upon for the statistical analyses in this study, some further notes about its origin are pertinent. The sample size, while large and inclusive of people from across the study area, is only a fraction of the total population: The approximately 70,000 people surveyed from the study households represent just 0.5% of AGBA's total population. According to my personal e-mail correspondence with Jorge Blanco, professor of geography at the University of Buenos

Aires, while the survey made a concerted effort to survey travelers of different backgrounds and modal preference, its representativeness, especially of marginalized groups, should be taken with some caution given its small sample size.

With the settlement pattern and political geography of the AGBA explained, the next two chapters focus on substantive issues related to two predominant characteristics of metropolitan Buenos Aires: its informal housing communities (i.e., the *asentamientos*) and its public transportation system. While these topics appear distinct, neither can be fully described or explained without the other. Understanding the history of the transportation system is necessary for understanding the perceived lack of services within the *asentamientos*. At the same time, the specific locations of AGBA's informal housing communities are a clear reflection of its mobility landscape, rendering it impossible to tell the story of either feature in isolation of the other. I will begin, in Chapter 3, by overviewing the transportation system because it is responsible, directly or indirectly, for shaping multiple aspects of Buenos Aires' contemporary urban geography, including its housing and mobility patterns.

Chapter 3: Transportation Infrastructure and Spatial Mobility in Buenos Aires

While volumes can be written on the various facets of metropolitan Buenos Aires' public transportation system, I profile two components critical to understanding the region's informal housing crisis: (a) the spatial expanse of the system and its modes and (b) the variation in mobility trends and modal splits between socioeconomic groups.

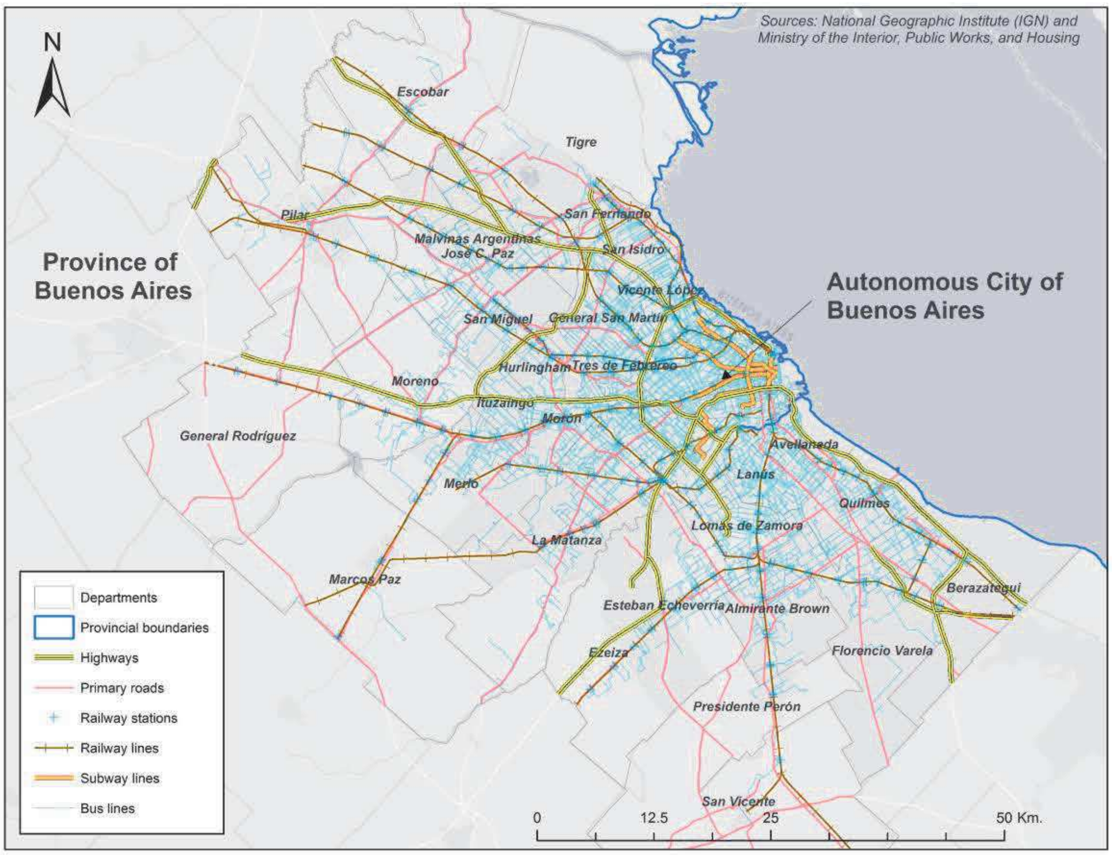

Figure 3.1: Transportation system of Agglomerated Buenos Aires (AGBA)

Illustrated in **Figure 3.1**, agglomerated Buenos Aires has a massive transportation system. Emanating outward from CABA and its central business district, the entire network features thousands of kilometers of commuter railways, subways, highways, and bus lines, as well as countless other forms of informal transit and non-motorized travel, all of which crisscross the territories of CABA and all the departments in AGBA. The distances covered by these modes are summarized in **Table 3.1**. The suburban railway network—consisting of seven radial commuter lines and 259 stations—operates on 670 kilometers of track alone! At the same time, there are over 340 bus lines (with a total length of 11,000 kilometers), serviced by 170 individual companies that operate 17,000 total units (CAF 2011). While there is a subway, it is entirely within CABA's boundaries. Motorways and national/provincial highway routes fill in the rest of AGBA's territory, the primary mode of travel for the many urban zones not adjacent to the railway network.

Table 3.1: Transportation infrastructure by INDEC agglomeration category (2018)

Geographic Area	Railroad trackage	Railroad Stations	Bus Route Length	Subway trackage	Motorways
C.A. Buenos Aires	85.0 km (13%)	43 (18%)	2,916.3 km (26%)	62.1 km (100%)	56.4 km (16%)
GABA, Totally-agglom.	190.2 km (28%)	93 (39%)	4,074.6 km (36%)	0.0 km (0%)	108.4 km (31%)
GABA, Partially-agglom.	231.1 km (34%)	73 (30%)	3,520.5 km (31%)	0.0 km (0%)	114.9 km (33%)
GABA	506.2 km (75%)	209 (92%)	10,511.4 km (92%)	62.1 km (100%)	279.7 km (80%)
Non-GABA, Partially-agglomerated	167.5 km (25%)	19 (8%)	883.8 km (8%)	0.0 km (0%)	68.0 km (20%)
AGBA	**673.72 km**	**228**	**11,395.14 km**	**62.14 km**	**347.66 km**

Sources: National Geographic Institute (IGN) and Ministry of the Interior, Public Works, and Housing (2018)

When looking at the spatial extent of the network, there are some striking trends. For one, the areas of densest transit coverage are in CABA and the districts immediately surrounding the federal district; coverage is substantially more dispersed in suburban departments. Second, the roadways and highways display a radial pattern, with nearly every line terminating somewhere within CABA. There is a near total lack of circumferential beltways (in contrast, as will be seen, to actual commuting trends in recent years). Buses, meanwhile, have the most extensive coverage, facilitating access within interstitial spaces between rail lines. The region's flat topography has allowed each mode—albeit at different times in history—to easily sprawl in all directions away from the city’s center and port, with few barriers to growth other than each other (Lascano-Kezic and Durango-Cohen 2012). The recent boom in highway construction has, unsurprisingly, followed suit. **Figures 3.2a-h** contain photographs, taken by the author, depicting components of AGBA’s transportation system: commuter railways, buses, trams, and subways.

Figure 3.2a: Constitución, the major commuter rail terminal in CABA for lines in southern AGBA

Figure 3.2b: Retiro, the major commuter rail terminal in CABA for lines in northern AGBA

Figure 3.2c: typical CABA subway platform for Line A, constructed in early 20th century

Figure 3.2d: typical CABA subway car for Line B

Figure 3.2e: suburban rail station in one of AGBA’s southeastern districts, under renovation

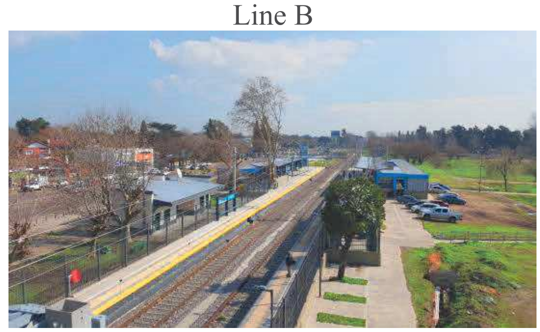

Figure 3.2f: typical suburban rail station in one of AGBA’s southeastern districts, after renovation

Figure 3.2g: typical city bus (a *colectivo*) running along a designated busway in central CABA

Figure 3.2h: car running along CABA's singular urban tramway line (known as the *PreMetro*)

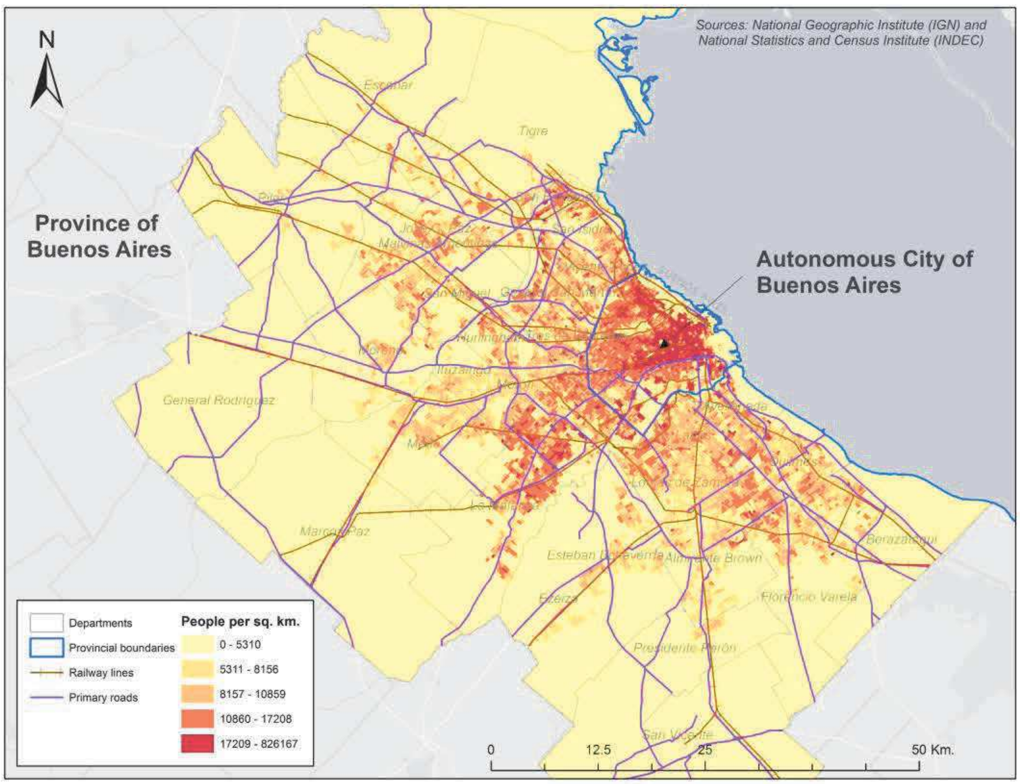

Figure 3.3: Population density (2010) in Agglomerated Buenos Aires (AGBA), overlaid with regional road and railway networks (2018)

Considering these route networks vis-à-vis population density patterns, as shown in **Figure 3.3**, showcases the important relationship between housing and mobility in Buenos Aires. While the history of this linkage is explored below, AGBA's population pattern will be shown to be a direct consequence of the different, and constantly evolving, transportation technologies available for workers to commute towards jobs in CABA's urban core. The initial railroads produced high densities around their fixed routes and stations, while buses subsequently allowed housing developments to sprawl across the remaining landscape, shuttling passengers either to their nearest railway station or taking them directly into the city center via an expanding network of public roads.

As a result, formal neighborhoods in AGBA were built anywhere within manageable travel times of CABA, which has largely remained the geographic center of employment in the region. As the conurbation grew outward, the innermost departments of the metro area have become entirely urbanized, with some possessing miniature central business districts of their own. Any land in AGBA that remains unoccupied, and beyond the reach of developers, either presents an environmental hazard of some kind (e.g. riverbanks prone to flooding, dumps, polluted industrial land, etc.) or is too far away from employment centers to feasibly permit commuting.

What has begun to alter the landscape, however, is the growth in automobile ownership. Cars, the newest major player on the mobility scene, are pushing the limits of low-density growth, with AGBA's newest suburbs closely resembling the auto-centric neighborhoods found around North American cities (at similarly long distances from downtown). The increase in individual mobility for certain groups (car ownership is strongest among the wealthy) has produced these drastic changes in housing geography. In turn, employment centers have also shifted, with service-type jobs now scattered across all of AGBA's departments. This contrasts with the pre-auto era when work was overwhelmingly concentrated in CABA's governmental, financial, or industrial areas. More people live and work outside of Buenos Aires City than ever before; **Table 3.2** reveals that a majority of all trips made in AGBA during 2010 were made within or between departments outside of CABA. As seen on **Figure 3.1**, however, the transport system has not responded to this trend. There is a dearth of transversal links (for railways and roadways) and the densest areas of transit coverage are in the urban core (Keeling, 1996; Blanco 2014; Secretaría de Transporte 2011). These territorial dynamics are echoed in Blanco and Apaolaza's statement that "due to the unequal distribution of infrastructures and the severe social fragmentation between different areas of [AGBA], differential mobility is also closely associated with … territorial structure" (2018, p. 5).

Table 3.2: Geographical distribution of trips in Agglomerated Buenos Aires, by region of origin and destination (2010)

Origin ↔ Destination	All Trips	Mode					Purpose		
		Bus	Rail	Subway	Car	Non-Motor.	Work	Study	Health
CABA ↔ CABA	24.6%	22%	5%	60%	22%	23%	27%	25%	25%
CABA ↔ GABA	14.1%	23%	56%	40%	18%	0%	20%	8%	14%
GABA ↔ GABA	61.3%	54%	39%	0%	60%	76%	53%	66%	61%
Total	100.0%	39%	6%	4%	18%	27%	37%	25%	4%

Source: Secretaría de Transporte (2011)

Alongside its physical expanse, the other aspect of AGBA's transportation system warranting discussion is the modal split and its variation by income. Looking first at the entire region, most trips are made on public transport (43%). Only 26% are made privately (primarily in personal autos but also including taxi rides) and a remarkable 31% are non-motorized (i.e., walking and biking). As for specific modes, buses (or *colectivos*, as they are known locally) are most common, taken for 39% of trips. Walking trips are next (24%), followed by private car (12%) and train/subway (10%). The relative prominence of public transit and walking, at least in comparison with driving, contrasts starkly with the bleak ridership trends common in the automobile-centric cities of the United States (in fact, only 64.9% of *porteños* own a car). Lastly, mode is also related to trip length. Most walking, bus, private car, or subway trips begin and end within the same or adjoining departments, whereas rail trips overwhelmingly begin in CABA and end in the provincial departments of AGBA (or vis-versa) (Secretaría de Transporte 2011).

Income data, collected with ENMODO, provide insights into modal splits vis-à-vis socioeconomic development. Using households' self-reported monthly incomes, users were classified into five quintiles, characteristics of which are contained in **Table 3.3**. While these values are estimations extrapolated from the sample of households surveyed and may not be fully representative of actual values, they exhibit some important trends. For instance, lower quintile families are typically less educated (most with nothing more than a primary education) and have larger households. Even more importantly, they spend proportionately far more of their income on travel than wealthier households.

Table 3.3: Characteristics of income quintiles developed from the ENMODO origin/destination survey (2009)

Income quintile	Quintile population (est.)	Average people per household	Average monthly income (pesos)	% of income spent on travel	Education level, most common
1st (lowest)	3.7 million	4.6	$1,321	17%	Primary
2nd	2.8 million	3.4	$2,193	13%	Primary
3rd	2.4 million	2.9	$2,987	11%	Secondary
4th	2.1 million	2.6	$4,116	9%	Secondary
5th (highest)	1.9 million	2.4	$7,424	6%	Secondary

Source: Secretaría de Transporte (2011)

When considering the mobility trends of the different quintiles (**Table 3.4**), lower-income groups overwhelmingly take public modes: 84% of the lowest-quintile versus 59% of the highest. Meanwhile, private modes are taken by over 40% of the two highest quintiles as compared to a mere 15% of the lowest income earners. Nearly a quarter of all trips on public transit were taken by the lowest quintile, while the opposite can be said for private modes and the wealthiest quintiles. This latter trend is emblematic of motorization trends in other cities in the Global South, where members of the higher classes gravitate increasingly towards private car travel as their disposable incomes increase (Vasconcellos 2001). This contrasts with perhaps one of the more striking income-based findings: that more than a third of walking trips are made by the lowest income bracket. Given that lower-income groups are common in Buenos Aires' periphery and its precarious housing settlements (areas with sparse transit services), this suggests that lower-income people are forced to walk to activity sites instead of taking transit.

Table 3.4: Travel preferences of income quintiles, as revealed from the ENMODO origin/destination survey (2009)

Income Quantile	Trip generation rate	Modal breakdown				
		Public Transit	Bus	Rail	Auto	Non-Motor.
1st	1.36	23.3%	24.2%	22.4%	13.9%	36.4%
2nd	1.46	20.5%	20.9%	20.0%	19.2%	21.3%
3rd	1.53	18.9%	19.1%	19.3%	21.2%	16.6%
4th	1.64	18.5%	18.2%	19.4%	22.3%	14.0%
5th	1.78	18.9%	17.6%	19.0%	23.4%	11.7%

Source: Secretaría de Transporte (2011)

These transportation statistics were the subject of a recent paper on income, travel expenditures, and mobility in metropolitan Buenos Aires. Guerra et al. (2018) modeled whether certain variables affected regional household travel expenditures. They found, unsurprisingly, that household income is a strong predictor of transport expenditures, especially when that household owned a car. Other variables—like distance from the center and households living in lower density neighborhoods—were also found to be positive predictors of expenditures. The paper has limited application to this study because there is no way of differentiating the mode-specific spending habits of each household. Given that automobile ownership and upkeep is inherently more expensive than transit, these results only really pertain to those people who own cars, a rarity for the lower-income Argentines that are the subject of this thesis. Any of Guerra's results equating certain population characteristics with transit expenditures, like the claim that job and transit accessibility increase spending, likely overrepresent the mobility habits of higher-spending car owners. Nevertheless, it is still striking—and an indication of the importance of this thesis—that Guerra's results show there to be three-times as many jobs accessible to car-owning *porteños* (a local demonym for Buenos Aires' residents) than transit-takers.

Chapter 4: A Historical Geography of the *Asentamientos*

While metropolitan Buenos Aires' public transportation system is an important component of this thesis, the main topic of interest is transit accessibility vis-à-vis another unique component (albeit related to housing) of the region's urban geography: its *asentamientos*. *Asentamientos*, a Spanish term that translates as "settlements," are a type of informal housing community common in AGBA but that are found exclusively *outside* of CABA. They were initially founded as illegal, if well-organized, occupations of vacant land that, over time, are slowly transitioning into formal neighborhoods. Aided in this process by the government and friendly NGOs, they are supposed to have benefited from the division and regularization of residential lots, provision of public services (e.g., plumbing, electricity, paved streets), and the ability of occupiers to eventually own the land upon which they settled and constructed their homes. Their inhabitants (called *asentados*), meanwhile, are primarily domestic migrants from Argentina's interior provinces but have grown to also include immigrants from neighboring countries in South America (notably Paraguay and Bolivia) and local residents unable to afford housing in Buenos Aires' formalized neighborhoods.

While all these characteristics define the *asentamientos*, perhaps their most important attribute is their location in the agglomeration's suburban periphery, beyond the borders of CABA (Van Gelder et al., 2013). This is important because it sets the *asentamientos* apart from the other primary form of informal housing in metro Buenos Aires, the *villa*. While *villas* are similarly illegal and home to destitute migrants, they are located exclusively in and around CABA. Sited in the region's urban core, *villas* exhibit higher population densities (with very little vacant land downtown, they are crammed onto miniscule plots of land). In contrast with *asentamientos*, they contain no formal street grids or urban form, provide residents with no path to land ownership, and see no formal services from the state or private utility companies.

Most *asentamientos* got their start when a group of homeless families collectively invaded an unoccupied tract of land in one of the conurbation's suburban departments. Typically, these *asentados* had previously lived in cramped housing in one of CABA's urban *villas* but could not afford a home for their entire families in any of the conurbation's formal neighborhoods. Hoping to find more land to inhabit in the less densely populated suburbs, they discovered that the progressive urbanization of Buenos Aires' suburbs—whereby formal neighborhoods had been constructed on the premium, most-accessible pieces of land in each district—had left few open spaces for settlement. The only vacant land was along riverbanks or near dumps, pollution-emitting factories, or dangerous infrastructure like railroads or high-voltage electricity lines or, in other words, land that would have been developed if it had any commercial value (Keeling, 1996).

Once settled in place, the *asentados* began to formally take-over the territory by laying a rudimentary street grid connected with the adjacent local street pattern, dividing up the land into individual parcels, and pressuring the authorities to provide essential services and award land ownership titles (Cravino et al. 2007). How quickly these things happened depended on the organization of a group of *asentados*. Essentially a form of institutionalized illegitimacy, *asentamientos* are simultaneously an illegal occupation of land and also part of the path to legally owning that same land (whereby residents comply with the same land titleship laws they broke in the first place). A paradox in and of themselves, they are a unique product of Buenos Aires' history and have not been well-studied, in any capacity, outside of Argentina. Some photos of an *asentamiento* in the Pilar district are shown below.

Figure 4.1a – Dirt streets are common, which are often impassible after a heavy rain

Figure 4.1b – The wall and gate of a self-constructed structure; some wires present

Figure 4.1c – Another self-constructed shelter, with some electricity wires present

Figure 4.1d – While uncommon in most settlements, some *asentado*s can afford used automobiles

Figure 4.1e – a cement wall separating the *asentamiento* from a neighboring gated community

Figure 4.1f – a small convenience store/grocer within the neighborhood, a sign of permanence

Most of the *asentamientos* definitional characteristics relate, in some form or another, to their location on the conurbation's periphery. For instance, they are often comprised of families who need more open space, uniquely available in these parts of AGBA, to build homes that accommodate greater numbers of people, whether children, grandparents, or siblings. The residents of *villas*, by contrast, only have space for little more than one room. In fact, many of the families moving into the *asentamientos* come directly from a *villa*, which are typically the first place most migrants live when arriving in Buenos Aires. After establishing themselves in the city (and accruing some form of capital), *villeros* will then relocate outward to one of the more spacious *asentamientos*. This move can be an individual effort—if the family is moving to preexisting *asentamiento*—or collective, if a group of families wishes to establish a new *asentamiento*. The process of starting anew requires substantial social organizing and the pre-identification of vacant, invadable land in the suburbs. *Asentados* are motivated to initiate such a difficult and risky process by the prospect of eventually owning a piece of land that can potentially provide them with increased residential security, an asset with economic value that can be passed on to future generations or sold to fellow migrant families, and general household stability in their new urban environment (Cravino, et al. 2008, pg. 175-179; Van Gelder, et al. 2013).

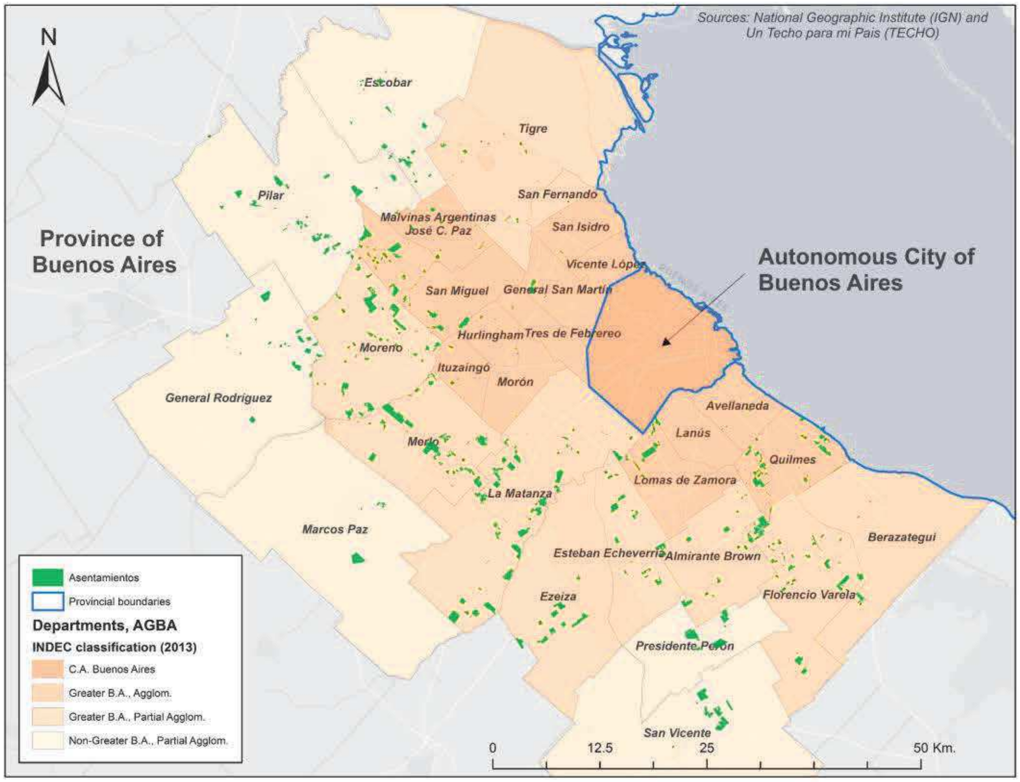

Figure 4.2: Distribution of *asentamientos* in Agglomerated Buenos Aires (AGBA) (2016)

It must be noted, however, that life in the *asentamientos* comes with many challenges. Perhaps the most pressing, public services have been slow to manifest. In most areas, residents lack access to clean drinking water, electricity, sewage removal, trash disposal, and transportation. Residents have either had to fight local authorities to provide these services —as has been the case with schools and health centers—or work together to provide their own (i.e., public spaces, communal eating hall). Few *asentados* have gained full ownership of their land and others have struggled to obtain credit or financial assistance, a consequence of banks refusing to lend to people whose home addresses are within a known *asentamiento*. Such funds are especially crucial for families who need to respond and rebuild after emergencies like floods, which often plague the low-lying *asentamientos*.

The education levels of asentamiento residents are low, restricting employment to low-skill positions. Exacerbating their already tenuous employment prospects, many of these jobs are found in far-off locations: Buenos Aires' core or the central business districts of AGBA's other departments. The poor quality of public transit in the suburban spaces where the *asentamientos* are found only worsens job accessibility and, as is widely suspected, increases unemployment. Families who choose to live in an *asentamiento* over a *villa* are faced with trading off the job access of the centrally-located, albeit crowded, *villas* for the more spacious, yet distant, *asentamientos*. Additionally, *asentados* often face discrimination by employers, service-providers, and even emergency services personnel who refuse to help people with home addresses in known *asentamientos*. Arce and Mino (2017) observed taxi drivers refusing to service certain low-income neighborhoods due to poor-quality streets and concerns about security. In fact, this example directly illustrates how residents of these communities are perceived by the rest of the population as being illegals, even in cases where they are citizens or have organized to acquire legal land ownership (Cravino et al. 2008, pp. 132–133, 188–190).

Examining the history of the *asentamientos* shows that they are nothing more than a collective response, geographically mediated by the region's transportation system, to incompetent planning and unfavorable government policies. Their continuous growth over the past four decades—through periods of economic boom and bust—contrasts with the inadequate provision of infrastructure and services to their residents, who number over a million (Keeling, 1996; Van Gelder, et al. 2016). While they exist in direct opposition to state oppression—as expressed through poverty, exclusionary housing policies, and the economic inequalities produced by neoliberal restructuring—these same forces also explain why the *asentados* nevertheless remain deprived of critical services, like transportation, that could greatly improve quality of life.

The roots of the *asentamientos*, in fact, lie in the early history of metropolitan Buenos Aires. For much of the city's history, the predominant form of illegal housing was the urban *villa*. As European immigrants and domestic migrants arrived in the city during its boom period prior to World War I, they would settle in informal tenements (called *conventillos* or *villas miseria*) near the port facilities and factories along the southern edge of what is now CABA. Overcrowded and nestled onto what little open land was available, they were usually the temporary homes of migrants as they first got settled and found jobs in Argentina. Conditions, nevertheless, were poor—densely crowded and built with irregular construction materials (typically waste materials from factories) and tight alleyways instead of formalized streets.

Around the same time, however, the region's transportation network was taking shape. A subway (known as the *Subte*) through the central business district, trolleys throughout the city's innermost neighborhoods and departments, and a vast network of railways, with a half-dozen lines branching outward from terminals in the city center, were all built during the first decades of the twentieth century (Keeling, 1996). With much of the land along these routes—especially the trams and railways—largely unoccupied beforehand (aside from agriculture), it was cheaply sold and developed into suburban neighborhoods for working class people previously stuck in crowded urban tenements. These developments would not have been possible without these railways and tramways, the former of which was originally built for exporting agricultural goods during the 1870s before eventually gaining the capacity to carry passengers. When faster locomotives arrived in the early 1900s, people could commute into Buenos Aires daily, living in settlements that sprang up within walking distance of the individual lines' stations. Train fares, moreover, were inexpensive. Initial growth came to many of the departments (e.g., Tigre, Moreno, Merlo, and Moron) that constitute those departments in AGBA now classified as "totally agglomerated" (Keeling, 1996; Pirez, 2002).

Aiding this growth were relatively lax housing regulations. A system of *loteos populares* emerged whereby developers could lay out subdivisions of empty lots, each with minimal services and infrastructure, and sell them cheaply to willing buyers. Customers, often low-income workers, took on the burden of constructing the house or providing basic services and the land was legally their own. (Van Gelder et al. 2016; Borthagaray and Natale, 2017; Blanco and Apaolaza, 2018). This shortened the stay of new immigrants in the *villas* as they could acquire the capital needed to purchase their own land relatively quickly. Buenos Aires' up-and-coming railway suburbs rapidly filled with former *villeros*.

In fact, the *loteos* ensured a consistent means of legal housing for low-income Argentines throughout the first half of the twentieth century, even as the number of migrants grew spectacularly. Between 1930 and 1970, the people living in CABA, and the departments of would-be AGBA, increased from 3 million and 1.8 million, respectively, to 3.5 million and 5.5 million. During the 1940s, failed import substitution policies contributed to this growth, pushing over 200,000 rural migrants into the city each year alone. Up through the mid-1970s, the continuous stream of people into Buenos Aires, comprised increasingly by migrants from Argentina's hinterlands and its neighbors in South America, was so great that the *villas* continued to house a substantial share of the population. Neither the *loteo popular* nor other government-support housing programs were able to keep up with the demand for formal housing (although these were both partially scuttled by domestic political and economic turmoil in the post-war decades). Consequently, hundreds of thousands of people had to continue living in the same crowded, unregulated, self-constructed communities in the city's center, becoming near-permanent fixtures of its landscape (Van Gelder et al. 2013; Van Gelder et al. 2016).

At the same time, the railway network—which had peaked in ridership during the 1930s—started into a long decline, the result of a botched attempt at nationalization. Without sufficient public investment in the system, it was marked with inefficient services, frequent labor issues, poor management, deteriorating infrastructure, and, most importantly, greater competition from buses and automobiles (Keeling, 1996). Buses gained their share of the market with cheap fares and flexible routes. Despite initial routes that exclusively fed passengers to rail stations, bus service gradually expanded into new, previously-unurbanized areas and even began to compete directly with rail. Their relative cheap operating costs were buoyed by domestic oil production, which deflated gasoline prices. Of key importance to this paper, the buses greatly expanded the territory available to commuters; the spaces between adjacent railways quickly filled in with new roads and developments and, as stated before, brought near-complete urbanization—except for river banks and polluted spaces—to those departments bordering upon the main city (CAF 2011). In time, the buses did not go where there was no development.

Major changes, especially to housing, came suddenly after the ascension of Argentina's military dictatorship in 1976. First and foremost, the military passed the Eradication Law in 1977, banning all *villas* from the federal district. Supposedly to curb overpopulation in the city, improve the city's image ahead of the 1978 FIFA World Cup, and to construct new urban highways, the *villas* and their 280,000 residents were evicted, with many of their homes demolished. At the same time, the military also oversaw a new national housing policy that eliminated the *loteo popular*, mandating that all new developments be fully stocked with requisite urban infrastructure. In the name of constraining urban sprawl, the new regime essentially killed the only legal avenue for low-income Argentines to own land. After the reform, the costs of new lots, with all the required services and utilities, was immediately prohibitive. To make matters worse, the military also halted rent controls in the city (part of a scheme to entice private housing developments). Rising rents, coupled with continued economic disarray, meant that many low- and middle-income *porteños* were shut out from legal land ownership in the 1970s.

Out of this policy triad emerged the *asentamiento:* the thousands of people fleeing the urban center, without an affordable, legal recourse to secure housing, collectively settled on whatever vacant land they could find. These spaces were either undesirable or undevelopable lands in those departments immediately bordering CABA or, in the outer departments, lands too distant from the urban core to feasibly commute on the existing transit system. By 1981, only 30,000 people were still living in Buenos Aires' *villas,* whereas 287,000 people were living in informal settlements in the periphery. Keeling (1996) states that 46% of them were within 30 kilometers of the center, 35% were between 30 and 40 kilometers, and 19% had to live in settlements beyond 45 kilometers.

Compared with the *villas* that many were fleeing, these *asentamientos* "came into existence as a consequence of an instantaneous and organized land invasion" (p. 1965), often with help from outside organizations like churches, NGOs, or lawyers (Van Gelder et al. 2016). The common decision to divide these spaces into lots and lay out a street grid contiguous with the surrounding neighborhoods was a direct legacy of the abolished *loteo*, the only model of land ownership known to Buenos Aires' working classes. These spaces were "in the urban periphery and generally in locations where there is less of an incentive to react for a landowner (whether the state or private) in comparison with the central areas" (Van Gelder, et al. 2016, p. 1965). Since the land was not often of value to its previous owner, there was generally less resistance (but not always) to the occupiers. Keeling (1996) tells the story of one *asentamiento* settled by exiled *villeros* along a riverbank in 1981. Despite being met with initial resistance from the dictatorship (who tried to bulldoze the complex but were stopped by protests), its occupants succeeded in establishing a formal neighborhood after the territory's previous owners agreed to sell the land (which had been unprofitable beforehand) to the state to be regularized (p. 106-7). As shown in this example, well-organized *asentados* were more likely to prevail and have their settlements popularly recognized (Van Gelder et al. 2013; Van Gelder et al. 2016).

While the military dictatorship collapsed by 1983 and was replaced by a democratic government, the issues facing the *asentamientos* did not much improve. This was especially the case with regard to the provision of services. For instance, even though the new government stopped the crack-down on illegal settlements and reversed the ban on *villas* within the city, neither the *loteo* nor rent controls returned. Most families chose to remain in the new *asentamientos* rather than return to the city (although some *villas* did reappear in the city in some of the same places where they had been previously destroyed). It did not help, however, that economic malaise persisted throughout the 1980s and early 1990s and kept many Argentines in poverty.

In an attempt to resuscitate the economy, the national government turned to neoliberal policies in the 1990s. Many public services, including gas, water, electricity, telecommunications, railroads, highways, and subways, were privatized, and land development opened to international actors. The implications for marginalized Argentines were deleterious: private utility companies stopped or reduced services for low-income groups, local governments lacked the authority, power, or will to counteract private interests, and land values increased in an unregulated, speculative real estate market. Meanwhile, federal legislation to officially regularize illegal land tenure and property rights in the *asentamientos* failed to materialize. When the Argentine economy collapsed in 2001–2002 due to the federal government defaulting on its enormous debt, earlier advances made in housing and service provision were wiped away. Estimates are that by 2002 over half of all Argentines were in poverty (Van Gelder et al. 2013; Van Gelder et al. 2016).

The period from 1990 to 2002 was particularly tumultuous for public transportation services, which continued their decline. The railways and subway system, bleeding money and passengers, were both privatized. Buses continued their ascendance while the government turned its spending and sanctioning priorities towards roadways. Privately-operated suburban motorways were constructed, linking the formerly-isolated and largely-agricultural northern departments with the urban center. Little was invested into railroad infrastructure or management as metropolitan Buenos Aires grew to exceed 12 million people by the end of the 1990s (CAF 2011). Pirez (2002) explores the effect of privatization on public services: "in the absence of any democratic decision making at the metropolitan level, key decisions are left to market forces … including developers and private companies now controlling privatized public services" (p. 145). Without a state presence, utility and transport companies concentrated their services in wealthier areas, where they could get the best return on their investments; poorer areas, including the *asentamientos*, saw fewer services and higher prices. As for transit, Pirez notes, "the metropolitan transport system is the best example of [post-neoliberal] fragmentation. Different modes of transport co-exist with no coordination other than that provided by the users themselves … [the result of] three regulatory systems in juxtaposition (municipal, provincial, and federal)" (p. 153).

One of the more well-documented consequences of these deregulations was the development of gated communities and auto-oriented suburbs in AGBA's peripheral departments. After the construction of the tolled motorways during the 1990s, upper- and middle-class *porteños* could live in suburban enclaves in distant departments, such as Pilar, and then commute, one-way, into the city center in just 45 minutes. Subdivisions were constructed on agricultural lands in these far-off municipalities, where officials relaxed land use regulations to attract developers. These homes, in turn, were attractive to well-to-do families who previously lived in the dense, albeit wealthy, neighborhoods on the northern side of CABA. Seeking larger homes, safer housing, and country club amenities, many families relocated to the suburbs. By the end of the 1990s, gated communities in the region's periphery comprised a surface area 1.5 times the size of CABA yet with just 17% of its population (Pirez 2002). This dispersion of population is another example of the regionwide trend away from Buenos Aires' traditional mono-concentricity, except, in this case, it was the upper class fleeing the urban core.

The remote departments located along the upgraded motorways had been cash-strapped and sought to take advantage of their newly-advantageous situations. Filled with cheap, underutilized land and desperately in need of tax revenue, they modified or waived planning regulations to lure real estate developers. Aided by provincial legislation that gave municipalities leeway over land development, these outer departments relaxed regulations to attract residents. Municipalities that had been nothing more than rural outposts along a railway line or provincial roadway, with nothing more than one or two small towns with limited, poor-quality public services, quickly filled with the homes of upper-class commuters. De Duren (2006) notes that construction booms immediately followed the completion of roadway projects in 1993 and 1996. Nevertheless, the services provided to these private developments were limited to just their residents. Many of the people who had previously lived in these municipalities, themselves quite poor, saw few direct benefits from their new neighbors. In Pilar, for example, "spatial changes were led by investors and did not correspond to a development of local government institutions, or to a local municipal plan on how to guide local growth … 80% of people still lacked piped water [by 2001] and sewerage" (De Duren 2006, p. 322).

Two trends have predominated since the 1990s: (1) the *asentamientos* have continued to grow with a persistent lack of access to requisite services with (2) public transportation showing initial signs of a rebound (although still poor in many areas). In terms of the former, the resurgent Argentine economy, which saw the government's debt paid off and a precipitous drop in unemployment, led to another real-estate boom, increasing land prices and rents, once again pushing at-risk citizens into informality. The victims of better times joined those that had been shoved out to the illegal *asentamientos* during the crash of the early 2000s. Recently, the government has made some inroads providing low-income citizens with housing. The Federal Social Housing Program was launched in 2004 with the goal of building 38,000 units in AGBA. It, however, has failed to produce widespread results. The FSHP lacked funds to purchase land for housing, meaning that many homes had to be constructed in inaccessible locations where land was cheap. Government reinvolvement in utility provision, a reversal of trends from the 1990s, has led to some improvements in services. The census in 2010 showed fewer homes in poor condition, even as the number of people living in informal communities exceeded one million. Like transportation, the responsibility for housing and land use policy also spans multiple levels of government, complicating the comprehensive planning needed to improve the situation in the *asentamientos* (Van Gelder et al. 2016).

Two primary sources, both from Argentina, provide ethnographic and qualitative information on the contemporary *asentamientos*: a 2013 report produced by an NGO working on housing and a 2007 study by an Argentine sociologist. The Argentine government does not officially recognize or define the physical boundaries of the *asentamientos* and *villas*. Consequently, this task is left to academics and non-profit organizations. The results of these two studies serve to (1) provide hard data and survey results to confirm the dire conditions of inequality in the *asentamientos*, (2) highlight the need for further studies of their transit services and mobility options, and (3) foreshadow some of the parameters that I included in my methodology.

The best source for contemporary information and socio-economic data on the *asentamientos* and *villas* in Argentina is the non-profit organization "TECHO," or "Un techo para mi pais."[2] Specializing in housing policy, TECHO is active throughout Latin America and often works in conjunction with local universities, government agencies, and civil society organizations. Among their many activities in Argentina, they and their partners have carried out extensive surveys of the country's informal housing settlements and produced an online map of their locations. Carried out by TECHO's Center for Social Investigation, the most recent survey (2013) provides details on the quantity, location, and principle characteristics of the country's informal settlements. The overarching goal of the surveys was to collect dynamic housing information that could be provided to authorities and community organizers working to improve the services and housing rights guaranteed to all of Argentina's inhabitants.

Carried out across Argentina during April 2013, a coordinated team of volunteers interviewed—using a series of pre-determined, standardized questionnaires—residents of 1,834 settlements nationwide. Data were collected on attributes commonly associated with the settlements: their geographic coordinates, status as *villa* or *asentamiento;* access to water, sewage, electricity, and gas; quality of roads; provision of street lighting; flood frequency; emergency service response rates; and distance to services. These data were cross-checked with existing surveys, government reports, and university studies, and entered into an online database, with the location of each settlement geo-referenced. The last of these steps, new to TECHO's 2013 survey, was done to specifically diagnose the accessibility of informal settlements to city services and infrastructure.

[2] http://www.techo.org/paises/us/

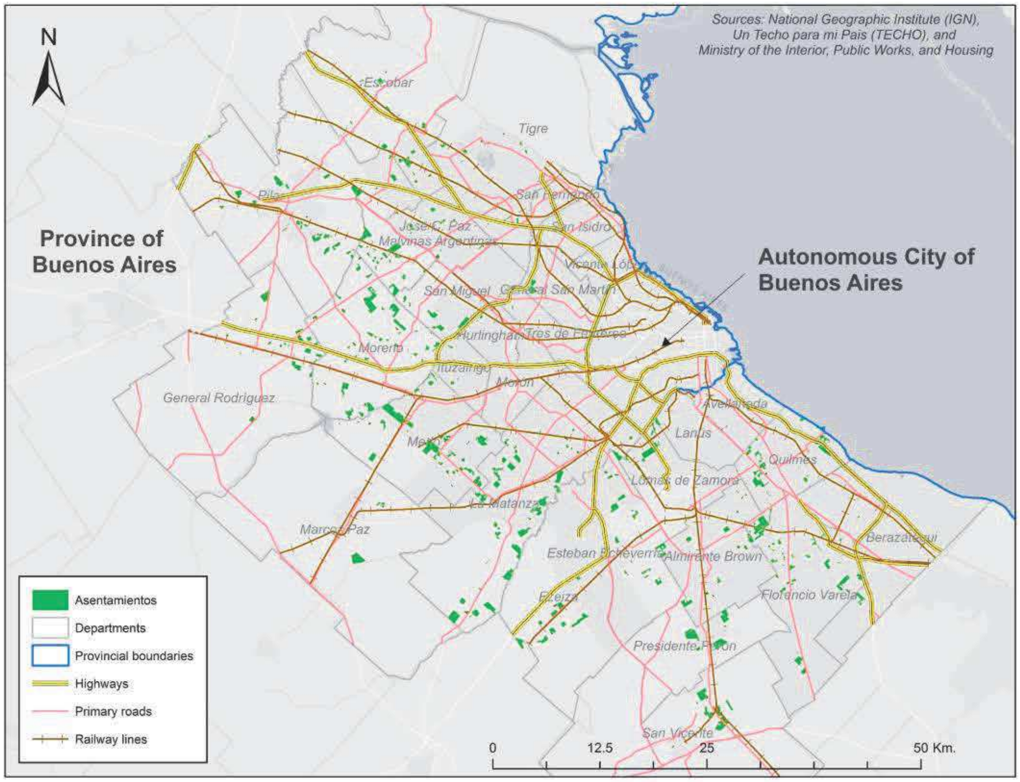

Figure 4.3: The *asentamientos* of Agglomerated Buenos Aires (AGBA), overlaid with major regional transportation infrastructure (2018)

While the project was carried out nationwide, the survey revealed there to be 786 precarious settlements in AGBA: 550 *asentamientos* and 236 *villas* (the former are depicted in **Figure 4.3**). Nevertheless, as TECHO itself acknowledges, it is important to remember these data are from 2013 and that conditions and quantities may have changed since (Gregorini 2013). TECHO's statistics on these *asentamientos* are contained in **Table 4.1**. Listed by department, I tabulated the number of communities and the number of resident families, together with the communities' total areas, densities, and populations relative to the rest of AGBA.

Table 4.1: Summary statistics for the *asentamientos* in Agglomerated Buenos Aires (AGBA), 2013

Department	% of AGBA Population	Number of *Asentamientos*	% of all *Asentamientos* in AGBA	No. of families in *Asentamientos*	% of all families in *asentamientos* in AGBA	Families per *Asentamiento*	Total Area of *Asentamientos* (km²)	% of Department Population in *Asentamientos*	% of Department Area in *Asentamientos*
C.A. Buenos Aires	**21.55%**	**0**	**0.00%**	**0**	**0.00%**	**0**	**0**	**0.00%**	**0.00%**
Quilmes	4.33%	43	7.40%	19,995	8.55%	465	5.4	15.78%	5.92%
José C. Paz	1.98%	26	4.48%	6,575	2.81%	253	4.1	11.37%	8.18%
Malvinas Argentinas	2.40%	20	3.44%	3,495	1.49%	175	1.1	4.99%	1.75%
Lomas de Zamora	4.58%	17	2.93%	11,440	4.89%	673	3.0	8.54%	3.40%
San Miguel	2.05%	17	2.93%	7,642	3.28%	450	2.7	12.73%	3.32%
Ituzaingó	1.25%	12	2.07%	819	0.35%	68	0.3	2.24%	0.76%
Hurlingham	1.35%	11	1.89%	3,011	1.29%	274	0.7	7.64%	1.92%
Avellaneda	2.55%	7	1.20%	2,305	0.99%	329	0.2	3.09%	0.43%
General San Martín	3.08%	6	1.03%	6,245	2.67%	1,041	0.8	6.94%	1.47%
Lanús	3.41%	5	0.86%	2,200	0.94%	440	0.4	2.20%	0.70%
Morón	2.39%	3	0.52%	125	0.05%	42	0.0	0.18%	0.04%
San Isidro	2.18%	3	0.52%	320	0.14%	107	0.1	0.50%	0.11%
Tres de Febrero	2.53%	2	0.34%	315	0.13%	158	0.1	0.43%	0.10%
Vicente López	2.00%	0	0.00%	0	0.00%	0	0.0	0.00%	0.00%
GABA, totally agglom.	**57.62%**	**172**	**29.60%**	**64,487**	**27.57%**	**375**	**18.9**		
La Matanza	13.20%	69	11.88%	34,681	14.83%	503	13.7	8.98%	4.19%
Moreno	3.36%	66	11.36%	18,423	7.88%	279	9.2	18.73%	4.94%
Florencio Varela	3.17%	48	8.26%	17,925	7.66%	373	7.7	19.36%	4.05%
Merlo	3.93%	46	7.92%	19,490	8.33%	424	10.3	16.96%	5.90%
Almirante Brown	4.11%	22	3.79%	11,040	4.72%	502	4.3	9.18%	3.35%
Esteban Echeverría	2.24%	19	3.27%	13,800	5.90%	726	4.0	21.09%	3.26%
Tigre	2.80%	16	2.75%	2,920	1.25%	183	0.8	3.57%	0.21%
Ezeiza	1.22%	12	2.07%	10,020	4.28%	835	3.9	28.15%	1.63%
Berazategui	2.41%	3	0.52%	460	0.20%	153	0.6	0.65%	0.27%
San Fernando	1.21%	2	0.34%	520	0.22%	260	0.0	1.47%	0.01%
GABA, partially agglom.	**37.64%**	**303**	**52.15%**	**129,279**	**55.27%**	**427**	**54.5**		
GABA	**95.26%**	**475**	**81.75%**	**193,766**	**82.84%**	**408**	**73.4**		
Pilar	1.73%	35	6.02%	13,170	5.63%	376	7.5	26.06%	1.96%
Escobar	1.32%	22	3.79%	7,980	3.41%	363	2.7	20.60%	0.88%
General Rodríguez	0.65%	21	3.61%	5,178	2.21%	247	4.0	27.22%	1.09%
San Vicente	0.33%	15	2.58%	4,685	2.00%	312	4.1	48.40%	0.62%
Presidente Perón	0.45%	9	1.55%	6,780	2.90%	753	4.3	51.82%	3.56%
Marcos Paz	0.32%	4	0.69%	2,340	1.00%	585	2.8	24.80%	0.65%
Non-GABA, partially agglom.	**4.80%**	**106**	**18.24%**	**40,133**	**17.16%**	**379**	**25.3**		
AGBA	**100.0%**	**587**	**100.0%**	**233,899**	**100.0%**	**399**	**98.6**		

Sources: INDEC (2010) and TECHO (2013)

The survey's results within Buenos Aires suggest significant inequalities. Starting with electricity, only 31.1% of the *asentamientos* have metered electricity, 6.1% have community units, and 62.4% have either irregular or no service. The results are not much better for sewerage; over a third reported having no more than a cesspool for waste disposal and a mere 3.3% are connected to the public network. In fact, the state is responsible for sewage in only 16.4% of the surveyed *asentamientos*, forcing neighbors to find their own solutions. TECHO reported similar findings for drinking water, where just 4.8% reported regular access to the public network, while more than 40.8%, the largest share, got their water through an illegal connection to that same grid. A majority of AGBA's *asentamientos* also lack asphalted roads (52%) and residents painted a tenuous picture of emergency services. Nearly a quarter felt that firefighters and the police sometimes, or even never, attended to issues in the community, with nearly a third saying the same about ambulance services.

Not all results were bad: residents of most of the settlements reported having state-sponsored trash collection and lighted streets (even if the community had to install the illumination. Somewhat similarly, environmental hazards were not as prevalent as popularly perceived. Large majorities (70%) of the communities did not have a dump, high tension power lines, train lines, industrial waste sites, large inclines, agricultural plantations, or landfills within even one-hundred meters of their settlement. Riverbanks, however, were the feature most commonly found within the confines (less than 50 meters) of an *asentamiento* (35%), followed by high-traffic roads (20%) and dumps

(15%). Curiously, this is the same percentage of communities that also reported rampant flooding after any rainstorm (common in the subtropical climate of coastal Argentina).

Table 4.2 Distances by destination types, from the *asentamientos* of Agglomerated Buenos Aires (AGBA), 2013

Service	Inside the neighborhood	Less than 10 blocks	11-30 blocks (1-3km)	31-50 blocks (3-5km)	Beyond 50 blocks (5+ km)
Kindergartens	11.5%	49.3%	24.9%	3.3%	10.9%
Primary school	10.9%	48.9%	25.6%	3.2%	11.4%
Secondary school	8.3%	42.8%	29.4%	5.7%	13.8%
Hospital	0.0%	2.6%	19.9%	23.4%	54.0%
Medical center	10.3%	39.2%	30.7%	6.7%	13.1%
Police station	1.2%	15.9%	38.6%	20.1%	24.3%
Public transit	19.8%	60.1%	8.9%	0.6%	10.6%
Plaza	23.3%	37.1%	18.0%	4.5%	17.0%
Recreation center	10.8%	26.2%	19.5%	5.1%	38.4%

Source: TECHO (2013)

Lastly, TECHO also inquired about the distances between each settlement and the nearest location where a range of services were offered. Shown in **Table 4.2**, the results are mixed. Schools, generic medical centers, and public transit stops all seemed to be close, whereas hospitals and recreation centers were much further away. Since these are low-order and high-order services, respectively, it is hard to immediately prognosticate on *accessibility* since we do not know how long it takes or how much it costs to get to these places. The proximity of schools and health centers is likely a good sign for service access, although poor quality streets or unreliable transit could make these journeys more difficult. Conversely, if good public transit to hospitals is available, their distant locations may not be much of a concern.

Altogether, TECHO's report showcases that some services are clearly lacking within or proximate to AGBA' *asentamientos*. This sentiment is captured in perhaps the most interesting of TECHO's interview questions, which asked residents about the greatest threat to their individual neighborhoods. While criminal activity/insecurity was a common answer, the largest cohort felt the lack of services was most grave. Using travel time data to quantify the provision of one of these services (public transportation) can help strengthen the argument to policymakers that inequalities exist and must be fixed

The other primary source for information on the *asentamientos* is the quantitative-ethnographic work of Argentine sociologist Cravino et al. (2008). Just one part of a larger project entitled INHABITAT, the author and her collaborators carried out a survey in four different *asentamientos* in metropolitan Buenos Aires—one each from the departments of Moreno, San Miguel, Quilmes, and La Matanza—during July and August 2006. While there was some variability between the communities selected in terms of degree of community organization, location relative environment hazards, help from outside NGOs, and service provision, there were also some commonalities: all were far from civic centers and hospitals, had poor quality roads, and lacked public spaces.

All in all, 480 people were interviewed. Their responses comprise the only direct documentation of living conditions and of residents' personal observations on life in the *asentamientos*. Unfortunately, the interviews were conducted more than a dozen years ago, and the respondents represent a tiny fraction of the million-plus *asentados* and *villeros* in metropolitan Buenos Aires. While I used their opinions and observations to shape parts of my methodology, I understand the risk that they are biased and out-of-date.

INHABITAT's findings, at least for 2006, corroborate many of the prior descriptions of the *asentamientos*. Those in the sample were young (most residents under age 40), most had migrated from the interior of Argentina, and a large number were poorly-educated. The sample included relatively few foreigners (only 22%, with most from Bolivia and Paraguay) and a near-majority (47.5%) had only a primary-level education. Just 0.2% made it to the university level and many were illiterate. A sizeable share of those in the sample—around 40%—were employed, with most in low-skill, temporary jobs. While few were fully unemployed, substantial numbers were on state-sponsored employment plans or reported being a housewife; almost none were retired. For those who worked, nearly all were in typical working-class positions: construction and carpentry (25%), domestic workers (17%), street vendors (13.7%), service sector workers (11%), and mechanics (4.2%) (Cravino, et al. 2008, pp. 92–144).

Their households, meanwhile, were crowded and lacked some of the same services discussed earlier. While running water and electricity were commonplace in the four study areas, sewage disposal was uncommon, creating unhygienic conditions that promoted the spread of disease. Less than a quarter of households had either a television or landline phone, something the authors attributed to the reticence of privately-held utility companies to extend services into the *asentamientos*. Even when these services were formally provided (and not merely clandestine connections to the grid), outages were still common. Lastly, these four settlements were all flood prone, with residents (the majority of whom either had self-constructed their home or purchased one from a prior owner) often at risk of losing property. Relatively few people owned their property; approximately 20% had proof of purchase or ownership of their land, whereas over 60% were merely occupiers. This, respondents felt, made it difficult to replace lost property or receive help from public authorities (Cravino, et al. 2008, pp. 169–175, 182).

Much like the TECHO report, INHABITAT also collected important information on mobility preferences and the geographic location of common activities. For instance, employed *asentados* primarily worked in their same department (48.1%) or within the neighborhood (28.8%), while 17.7% traveled to jobs in a separate AGBA department and 8.7% went into the federal district. In **Table 4.3**, some of the other common trip types—and their destinations—are summarized. Few activities took *asentados* far beyond their neighborhoods; everyday shopping (e.g., for groceries), the purchase of construction goods, schooling, socialization, and religious practices all took place nearby. Only shopping for luxury goods (e.g., furniture, appliances) required lengthy trips, if purchased at all. In terms of familial trips, many respondents either had no family in the area to visit or, if they did, their extended members often lived with them or in the same *asentamiento* (Cravino, et al. 2008, pp. 185–188).

Table 4.3: Geographic location of quotidian activities undertaken by the residents of Agglomerated Buenos Aires' *asentamientos*, 2006

Activity	Inside Asentamiento	Immediately Around Asentamiento	Outside Asentamiento, Same Department	Outside Asentamiento, Another Department	Not Applicable
Everyday Shopping	79.8%	21.9%	2.1%	3.8%	
Luxury Goods	4.6%	22.7%	22.1%	23.0%	28.3%
Construction Goods	4.6%	41.0%	9.2%	4.8%	40.0%
Study	24.0%	32.3%	6.7%	12.0%	22.1%
Socialized with Friends	53.3%	7.9%	6.3%	3.1%	29.0%
Practiced Religion	56.9%	24.6%	11.2%	7.3%	

Cravino, et al. (2008), pp. 117, 119-120, 122

As for the modal breakdown of these trips, most people reported taking the bus, followed closely by those who traveled on foot or biked. Merely 5% rode the train (although, as the authors mention, the four surveyed sites were all far from the nearest stations), and only 1.5% reported owning their own car. While data on the quality or frequency of these transit services was not collected, some respondents' answers alluded to an apparent crisis. One person felt unable to rely on the available public transit system to reach relevant employment sites, another felt it might be worthwhile to simply move to an *asentamiento* or *villa* closer to job opportunities, and a third commented that her neighborhood was essentially isolated, like a "desert" or an "island", given the difficulties of accessing proper services and employment (pp. 166, 175). All indicators from the survey results point toward inequitable access being a significant problem for *asentados*.

Alongside these qualitative studies, INHABITAT also performed basic geospatial analyses to tabulate the distances between the *asentamientos* of greater Buenos Aires (the results are contained in **Table 4.4**). Centered on their own dataset of *asentamiento* locations, they determined the average distance from each settlement to its nearest health center, clinic, hospital, primary school, secondary school, middle school, kindergarten, and public transit stop. Looking at the results, public schools were, on average, the closest feature class, followed by public transit, health centers/clinics, and private schools. Interestingly, the results were disaggregated based on whether a given settlement was closer to CABA (first-ring) or further away (second-ring). The results indicated that peripheral settlements had to travel further to reach each destination type.

Table 4.4: Distances to common activity sites from the *asentamientos* of Agglomerated Buenos Aires (AGBA), 2006

Destination Type	Distance to Destination Type		
	Across Entire Metro Area	First- Ring Departments	Second-Ring Departments
Health Center, Public	0.6 km	0.6 km	0.7 km
Clinic, Public	0.6 km	0.6 km	0.7 km
Hospital, Public	2.5 km	2.0 km	3.4 km
School, Any	0.3 km	0.3 km	0.4 km
School, Public	0.4 km	0.4 km	0.4 km
School, Private	0.6 km	0.5 km	0.8 km
School, Initial Level	0.7 km	0.6 km	0.7 km
School, Primary Level	0.5 km	0.5 km	0.5 km
School, Middle Level	1.0 km	0.9 km	1.2 km
Public Transit Stop	0.4 km	0.3 km	0.6 km
Public Transit Stop, with at least 3 lines	6.3 km	4.1 km	10.0 km

Source: Cravino, et al. (2008)

It must be noted, however, that these calculations—from all indication—are simple Euclidean, straight-line distances and originate from only those *asentamientos* identified by INFOHABITAT during 2006–2007, which are somewhat inconsistent with the more recent map created by TECHO. Furthermore, and as will be explored in the literature review on accessibility measurement in the next chapter, these are physical distances that do not necessarily reflect the actual amount of time or money that would be required to access the destinations. Simple spatial proximity is not relevant if that journey is costly in time or money. Just as with the data produced by TECHO, my project builds on these existing data by adding the element of time.

While it would be nice to have data from a larger sample of households in AGBA, like from a census, there is not much information on the *asentamientos* from the ENMODO travel survey. While it did record households' housing types, the only category that pertains are those labelled "villa de emergencia," which could hypothetically apply to any informal or illegal housing (*villa* or *asentamiento*). Without knowing the degree to which such areas correspond specifically to *asentados*, I choose not to use data or summary statistics for them (Secretaría de Transporte 2011).

Switching gears to present-day transportation conditions, Lascano Kezic and Durango-Cohen (2012) provide an excellent overview of planning politics and ridership patterns, helping to illustrate why I expect mobility conditions for the *asentamientos* to be relatively poor. For instance, transportation planning responsibilities in AGBA remain atomized between federal, provincial, and municipal governments, a problem that persisted throughout Buenos Aires' metropolitan history. The national government controls the commuter railways (re-nationalized in the 2000s), subways, highways, and buses that run routes between the federal district and the outlying province. It also holds ultimate authority over all funding responsible for projects that involve both the city and the province. The national government additionally controls transit subsidies, which are a substantial expenditure, amounting to 0.7% of national GDP in 2012 (Guerra et al. 2018). Initially introduced during the 2001–2002 economic crash, these subsidies keep transit fares affordable for many low-income *porteños* but have consequently diverted funds away from the maintenance and upgrade of the existing system (Guerra et al. p. 106).

Meanwhile, the province regulates all transit routes that cross across municipal borders, and the municipalities have control over routes that lie within their own boundaries. These distinctions are most important for bus companies, who receive government contracts to run their routes. Railways and highways, inherently larger-scale operations, naturally fall under federal jurisdiction compared with locally-oriented modes. The city of Buenos Aires, meanwhile, controls only bus stop locations, subway extension planning, and taxicab licenses. CABA's limited scope is noteworthy given that it operates its own planning agencies, has nearly a quarter of the metropolitan area's total population, and represents a substantial proportion of the region-wide tax base. In fact, CABA's unique status is reflected by the fact that the entirety of the subway network is within its boundaries as well as all of the region's bus rapid transit lines.

Alongside the disarray in planning circles, the number of people owning private automobiles has skyrocketed as Argentina's economy has stabilized and produced a growing middle class. This has, in turn, siphoned away much-needed fare revenue and ridership from buses, subways, and commuter rail lines. Lascano-Kezic and Durango-Cohen (2012) note that these motorization trends have been ongoing for decades but have accelerated in the last twenty years, aided by government subsidies, new highway construction, and users discontented with poor-quality transit (pp. 110-1). **Table 4.5** shows the remarkable ascension of automobile traffic, as a share of all travel, in the past half-century, an increase of nearly 30% (CAF 2011).

Table 4.5: Share of all trips by travel mode in Agglomerated Buenos Aires (AGBA), 1972-2007

Mode	Share			
	1972	1992	1996	2007
Bus	54.3%	49.9%	42.7%	31.3%
Subway	5.4%	3.6%	4.3%	3.7%
Train	7.2%	6.4%	6.5%	5.1%
Automobile	15.4%	24.3%	31.4%	41.9%
Total number of trips (millions)	17.4	18.0	19.3	26.3

Source: CAF (2011), pg. 30

Public transportation, the traditional leader in Buenos Aires' modal split, has seen some improvements in recent years despite losses relative to private automobiles. Trains, still losing traffic and revenue compared with their heyday, were initially franchised out to private operators during the 1990s and then partially re-nationalized during the 2000s.

Since then, they have seen some new investments (electrification of railway lines, for instance). Ridership levels are at approximately 250 million people, and the rail lines remain one of the easiest ways to reach the city center from the metropolitan outskirts (see **Table 3.2**). A legacy of their role as the initial progenitors of suburban growth in AGBA, the areas around their stations have high residential densities and serve as local centers of commerce even as ridership has collapsed (Blanco 2014). Trains have struggled against a negative popular image, with a now long-established legacy of poor service quality, rampant safety violations, insufficient investment in capital (e.g. tracks, stations, locomotives, and rail cars), poor on-time performance, significant fare evasion, and debates over funding. Significant improvements are still needed.

Buses, meanwhile, have retained their spot atop the regional modal split and are still privately-operated. Companies continue to bid on routes put out by the state (the location of a given route is determined by the government body whose jurisdictions it serves) and awarded to them through concessions. While not strictly a public service, the companies are still held to federal safety and technical regulations and have received help in purchasing and maintaining new equipment. Furthermore, efforts have been made to ensure intermodal connections, with buses now stopping at rail or subway stations to facilitate connections. In some parts of the metro area (albeit primarily within CABA), segregated bus lanes have been installed. Fares—which are distance-based—are heavily subsidized by the state, with discounted tickets available to seniors and students (Guerra et al. 2018). As seen in the ENMODO results, the bus is also the preferred mode of the lower classes: the busiest routes, as it turns out, are those serving southern and northwestern departments of AGBA, where many of the region's poor, working-class people (including the *asentados*) are to be found (Keeling, 1996).

Recent transportation system improvements, however, have overwhelmingly favored residents of CABA and the wealthier communities in the region's periphery. The federal government, alongside the city and provincial governments, has pushed the electrification of suburban railway lines, expanded the City's subway system, and constructed several bus rapid transit corridors throughout the City of Buenos Aires. It has also implemented a region-wide fare card program (known as the SUBE), helped fund the purchase of newer vehicles, added a transit safety agency, and added university programs in transit engineering (CAF 2011; Borthagaray and Natale, 2017).

In AGBA's peripheral zones, away from CABA and its wealthy residents, services are still poor, with chronic congestion, unreliable services, frequent accidents, poor management, and transit that is over-capacity (CAF 2011; Gutierrez 2014). Some scholars, like Pirez (2002), Gutierrez (2014), and Blanco (2014), attribute this imbalance to inequitable spending on automobile-based transport—which has increased air pollution and street congestion while attracting paying customers away from transit—and the lack of a proper, regional planning authority. If such a body existed, transportation and land use planning could be coordinated comprehensively, with departments working together with the federal, provincial, and CABA governments, to ensure that the transit system is more efficient and equitable for all *porteños*, not just the minority wealthy enough to drive or to afford buy or rent their own home or apartment.

While the city enjoys walkable streets and transit coverage greater than 90%, substantial mobility problems remain for those living far from the central business district. Despite the continued growth in the conurbation's periphery, "Greater Buenos Aires concentrates residents and overall wealth in the central city. The densest neighborhoods are centrally located and emanate radially from the center … [and] the highest income households are located in central locations of Buenos Aires, where the best transportation infrastructure and urban amenities are located" (Guerra et al., 2017, p. 3). Pirez (2002), despite writing over a decade ago, correctly observed that there "is no democratic decision-making process at the metropolitan level, so key decisions are left to the market ... and more powerful economic actors (such as developers and private companies providing public services) … without the necessary accountability to the citizens that represent the real city (p. 158)."

In conclusion, there is ample evidence to support the hypothesis that the residents of metropolitan Buenos Aires' ***asentamientos*** **should experience poorer transit-based access, to daily activity sites than those people living in the formal, legally-established neighborhoods that surrounded them. It is this hypothesis, to be quantified through transit-based travel times to strategic daily activity sites, that I explore in the analytical component of this thesis.** The contributing factors I have discussed thus far are, first and foremost, that *asentamientos*—by their nature—are found exclusively in peripheral spaces, both relative to their individual districts and the whole metropolitan region. If the land upon which they were settled was more transit accessible—and not already plagued by floods, pollution, and other environmental hazards—it would have been developed. While it could be argued that their peripheral locations will inherently make travel times longer, this is still not an excuse for not providing essential, accessibility-enhancing transportation services to these areas.

Aiding this initial spatial disadvantage is the long-ongoing deterioration of transportation and other public services in the metro area; since the 1950s, rail and bus services have been poor, especially in the metropolitan periphery. Aside from the recent construction of wealthy gated communities, the periphery has always been resource-poor compared to the cosmopolitan city. With fare revenue lost to personal cars and the general disengagement of the state from the economy through neoliberal regulatory policies, decreases in transit-accessibility are to be expected everywhere, with the worst impacts felt by those marginalized, underrepresented people living in *asentamientos* in some of the region's most isolated, precarious locations. Lastly, with profit-minded utility companies choosing to forgo low-income areas in other spheres, it would come as no surprise to see longer travel times for *asentados* than their (relatively) wealthier neighbors, a reflection of infrequent, overcrowded, and under-supported transit services. Transit providers and government officials have little incentive to provide higher-quality services to the *asentados* even if they need them the most. Despite being transit-dependent, their low-incomes and stigmatized popular image likely hinder the ability to attract equitable transit services

Chapter 5: Accessibility, Literature Review and Applications

The primary concept underlying this thesis is *accessibility*. Seemingly simple, it has been conceptualized and operationalized in many ways and, as acknowledged in the literature, there is no singular interpretation that can always be called upon. It varies based on context, a characteristic reflected in the array of definitions for *accessibility* and *access* in the literature. Nevertheless, as explained by Handy and Niemeier (1997), nearly all conceptualizations acknowledge, whether explicitly or implicitly, that it is characterized by two basic, yet highly-interconnected, components: (1) the distribution of activities (origins *and* destinations) across a territory and (2) the ease and costs of travel through a transportation system between those points. This second component is especially critical to this study because, without the means to travel across a space, the actual distribution of destinations is substantially less important. Considering accessibility as just a factor of physical separation does not fully capture the realities and constraints of individual mobility. This is particularly true for low-income groups, like the *asentados*, whose time and monetary budgets are exceptionally limited compared with their fellow urbanites, substantially restricting their ability to move about the landscape. In the absence of cost-effective mobility services, low-income people (like the *asentados*) are impeded from reaching important destinations, regardless of proximity.

A definition of accessibility that emphasizes constraints on mobility is from Hansen (1959): "*accessibility* is a measurement of the spatial distribution of activities about a point, adjusted for the ability and the desire of people or firms to overcome spatial separation" (p. 78). In other words, it is ultimately about whether people can reach the places they need to go to carry out their daily necessities. When accessibility is high, people can reach wherever they need to go in a cost-effective manner. When it is low, people struggle or fail to reach important destinations, burdened by time- or cost-ineffective means for overcoming distance. Ideally, all people will enjoy a high degree of access, regardless of their location or socioeconomic condition. Similar definitions have been given by Guers and Van Wee (2004), "the extent to which land-use and transportation systems enable (groups of) individuals to reach activities or destinations by a means of a (combination) of transport mode(s)" (p. 128) and Handy and Niemeier (1997), "the spatial distribution of potential destinations, the ease of reaching each destination, and the magnitude, quality, and character of activities found there" (p. 1175).

These definitions underscore the measurement of accessibility adopted by this thesis. To measure the cost-impedance faced by AGBA's *asentados* as they attempt to travel between their homes and important activity sites (e.g., schools, health care, employment centers, train stations), I calculated public transportation-based travel times. I focus on the role of public transportation services as the mechanism for overcoming spatial separation because this is the likely mode of longer-distance travel for *asentados* (shorter, neighborhood-scale trips only require walking or biking). By considering the time-cost of travel, I am moving beyond any of the existing studies of access in the *asentamientos*, like Cravino, et al. (2008), which looked exclusively at the physical distances separating the communities and their service providers and not whether the *asentados* can time-effectively reach those sites. If I can show that the *asentamientos'* residents require more time to reach daily activity sites than it takes those living in formal neighborhoods, I can provide an illustration of *relative* accessibility conditions for the residents of metropolitan Buenos Aires' many precarious settlements.

Given that accessibility is fundamentally about whether people can feasibly reach destinations distributed throughout space, conceptualizing and operationalizing accessibility is of great importance to the geographers and planners who study those mobility services that help people move across space. When accessibility metrics produce low scores, it indicates that the current transport system, and all its constituent modes, is not meeting the mobility needs of its users. Cervero (2011) notes, for instance, that poor accessibility makes it difficult for people to reach jobs and schools, limits economic mobility, and promulgates social isolation, unemployment, and low wages (p. 7). Garett and Taylor (1999) reached a similar conclusion, noting that planners and policymakers, without a full understanding of the consequences of the spatially-uneven distribution of public investments in an urban area, can unintentionally create a situation where "poor or mediocre public transit service in areas with high proportions of transit dependents exacerbates problems of social and economic isolation" (p. 393).

In fact, the role of public transportation should be to promote accessibility, especially for those without private means for traveling the distances requisite for finding employment, attending school, seeking healthcare, and fulfilling other basic human needs. Jaramillo et al. (2012) contend that some traditional transport planning methods have overly-focused on managing urban transport system demand rather than studying socio-economic impacts. Lucas, an expert on the social consequences of inadequate transit, adds that emphasizing traditional methods of analyzing transport's negative economic and environmental impacts has resulted in a serious lack of attention to its significant social impacts like social exclusion (Lucas and Jones, 2012). Social exclusion, frequently cited as a consequence of an underperforming transportation system, is a process "by which, due to an insufficient or inexistence of adequate means to travel, people are prevented from participating in the economic, political, and social life of the community … a result of reduced accessibility to opportunities" (Bocarejo and Oviedo 2012, p. 144). Measuring and observing accessibility conditions should be prerequisite for transportation policies aimed to preventing social exclusion.

With substantial implications for poverty and economic disadvantage, the same authors believe transport authorities must work to identify geographic areas of need and to prioritize strategies to spatially target and deliver mobility assets to the transport-disadvantaged. Augmenting this plea, Jaramillo et al. (2012) argue that one way to ensure social inclusion is through "improvements and/or implementation of a high-quality network of public transport with tariffs suitable for [disadvantaged] sectors" (p. 340). Any solution, they say, must directly incorporate the needs of all people, not just those with the greatest demand. Explicit plans should be made to incorporate transport-disadvantaged groups like the poor, the carless, the disabled, those unable to speak the local language, and children. The fact that the urban poor are overwhelmingly forced to live in peripheral areas of cities around the world, a decision itself part of a larger trade-off between housing and transport costs, should not impede them from taking part the benefits associated with city life (Cervero 2011).

The impacts of improved accessibility, in turn, are many. Keeling (2008), for instance, notes that "transportation enables poorer communities to [reach] basic economic activities and social services and facilitates accessibility to opportunities … [it] reduces the friction of distance between places and regions" (p. 141). He also extolls the virtues of high-quality transport for promoting economic competitiveness, lifting people out of poverty, and reducing inequality. Without the mobility and accessibility provided by transportation infrastructures, services, and technologies, people, places, and capital would not interact, stymieing socioeconomic development (Keeling 2002). Cervero (2011) notes that "for many … the availability of good, reliable, and affordable bus and rail services can be the difference between being integrated into the economic and social life of a city or not … a lifeline to participation in society's economic, social, cultural, and religious offerings" (p. 5). This is particularly true in market-driven societies, where the going-price for transportation is many times above what many citizens can afford. Without an affordable, accessible alternative, they are shut-off from accessing those activity sites beyond their immediate surroundings.

Blanco and Apaolaza (2018) expand on the relationship between accessibility and space, emphasizing that accessibility is a consequence of both location and socioeconomic conditions. While the authors acknowledge that socio-economic disadvantage and the lack of mobility assets (e.g., fare-paying capacity, vehicle ownership, drivers' licenses, transit-using competencies, system knowledges) go a long way to explain limitations in certain groups' access to urban transport services, they posit that the territorial configuration of these groups is equally as important. Referencing the proximity of groups to services, activities, and transport infrastructure, itself, the authors contend that, "the same transport supply and territorial configuration could be advantageous to a particular social group and not for another, while the same [mobility resources] of households and individuals could be advantageous in a certain specific territorial context but not in others" (p. 2). In other words, the accessibility conditions of a group must always be considered vis-à-vis their socio-economic resources and their location. The same system can disadvantage some groups and advantage others. This echoes an earlier conclusion from Bocarejo and Oviedo (2012) that "accessibility can be related to the time and percentage of income spent on commuting [and] the type of user, [his or her] location, and [the] mode" … "showing general higher incidents of time in richer areas and the important effect of money over accessibility in low income areas" (p. 153). While accessibility is crucial in many ways, it is essential to recognize that it takes different forms based on characteristics of the user and the spaces where she or he lives.

Seeing the importance of accessibility to the urban environment, it comes as no surprise that many have tried to operationalize and measure it as a mechanism for evaluating whether existing systems are adequately and appropriately serving their constituents (Litman, 2002; Manaugh and El-Geneidy, 2012; Taleai, 2014; Dadashpoor et al., 2016). Talen (1998) advocates mapping as a tool to "elucidate equity variation" and analyze "the spatial incongruity between resource need and … distribution" through the mapping of disadvantaged groups alongside the "local distribution of public facilities" (p. 23). In the context of transportation, scores of academics and planners have compared spatial gaps in transit coverage with socioeconomic data, determining if supply is appropriately commensurate with demand, especially in areas with marginalized peoples.

In fact, questions of transportation and access are at the forefront of a recent and growing scholarly interest in devising measures to assess the accessibility impacts of transport interventions. Studies looking at accessibility impacts include those focusing on a diverse array of common activity sites like health facilities, supermarkets, social services, parks, and even the transportation system itself (Tsou et al., 2005; Chang and Liao, 2011; Delmelle and Casas, 2012; Venter et al., 2013, Taleai et al., 2014). The goals of these studies are, as explained by Handy and Niemeir (1997, p. 1176) “providing planners and decisionmakers with [an] assessment of the implications of potential investments for the daily lives of residents” and helping them to strategically improve accessibility conditions. These measures can inform decisions like building new affordable housing units, relocating employment sites and critical services, or restructuring a transportation system outright (e.g., new routes, improved schedules, more comfortable vehicles). As noted by Delmelle and Casas (2013), “identifying population groups with limited access to opportunities” is complex, requiring highly-specific measurements of accessibility that, over the course of time, have taken many different shapes, forms, and interpretations.

Handy and Niemeier (1997) outline some common methods of measuring access and provide strategies for calibrating the metric of choice. They categorized the metrics into three groups, each of which makes different assumptions and generalizations about the two main components of access, land use and travel system. The first of the three are *cumulative opportunities measures*, which reflect, as the name suggests, the occurrences of a given category of activity sites that can be reached from an origin within a certain time, distance, or cost. All instances of a destination category within a certain threshold are counted, regardless of the specific travel time, distance, cost, or any other quality or characteristic of those individual activity site. Each origin point is assigned just a number (a summation), with no other output. These measures are the simplest, the easiest to understand and communicate, the least data intensive, and the quickest to calculate.

The second classification, *gravity-based measures*, weight the attractiveness of potential destinations as a function of the cost, distance, or time required to reach each individual instance. With measures of this type, closer locations are weighted more heavily than those more distant. An approach initially promoted by Hansen (1959), this method is more complex than the simplistic *cumulative opportunities* measures because it factors in the human tendency to travel to one of the closest acceptable opportunities. Along these lines, however, the gravity model is also useful for scenarios where people may be willing to travel to farther destinations that offer specialized goods, features, or services not available at other sites closer to their origin.

In a gravity-based measure of accessibility, the equation used to model distance-decay is typically a negative power or negative exponential function whose deterrence parameter can be altered based on the characteristics of given activities. Some activities may be able to draw people from farther distances than others, requiring a change in the exponent of that equation. While gravity-based measures may provide a more nuanced picture of accessibility than cumulative opportunities measures, they require more computation, can be harder for the layperson to understand, and, as importantly noted by Delmelle and Casas (2013), can be highly subjective, depending on how activities are weighted. In fact, it is hard to know what exactly drives people to travel, or not travel, longer distances for a good, making these data difficult to accurately obtain.

The third category distinguished by Handy and Niemeier (1997) are *utility-based measures*. These attempt to proxy the probability that a person from a given location will choose to make a certain trip based on selecting, from a range of choices, the alternative that maximizes his or her utility. They are often calculated at a spatially-aggregate level, predicting travel preferences for entire neighborhoods or districts, with utilities compared across a large region. They are the most complex type of measure, produced by advanced travel demand models that rely on complex mathematical formulas and economic choice theories. Their greatest limitations are their computational complexity, steep data requirements (detailed survey data on consumer preferences are needed), and their difficult for the average person (or policymaker) to understand. They warrant highly-specific data that presuppose individualized surveys that summon particular responses.

Regardless of which measure is chosen, certain considerations must be made. One is the degree of spatial aggregation. Access can be measured for large areas like cities or neighborhoods and smaller areas like households or individuals. Larger-scale units require less total data, but assumptions must be made about how to generalize the needs of the people living therein. Small-scale, household- or individual-level studies give a fine-grained understanding of individual accessibility but are less generalizable across a region and are data-intensive and necessitate costly surveys. Secondly, destinations must also be considered, with activity sites representative of the people under study—locations that "residences perceived to be available to them" (Handy and Neimeier, 1997, p. 1179). This furthermore requires one to consider destination attractiveness. The size or quality of certain features may draw people from further away than otherwise assumed. Some features, like public schools, draw mainly from surrounding areas while others, like hospitals, can draw people from further away if they offer a unique good or service. Perhaps only certain schools or stores are salient to a given group of people.

Another consideration is the quantification of travel impedance. Traditionally, this was done as a distance measure, whether Euclidean, Manhattan, or network-based. However, distance alone is not enough to fully represent access; distances are meaningless if people have no means of crossing them. As such, time- and cost-based measures are better (*if available*). Time-based measures, traditionally difficult to estimate without going into the field, are now possible thanks to recent innovations in geographic information systems and travel forecasting models. It is even possible to estimate travel times on transit alone, even accounting for variations in trip-length caused by restrictive transit schedules or congestion (Lei and Church 2010). Similarly, a cost-function can be added to capture the financial burden of a trip. Comparisons across modes are also possible, representing the choice set available to a traveler when deciding how to reach a destination or whether the trip is feasible in the first place (i.e. transit against driving, transit against walking, or biking against walking).

Handy and Neiemer are not the only authors to categorize accessibility metrics. Geurs and van Wee (2004) offer a similar classification system. They believe a measure needs to consider four things: land-use patterns in a region, transportation systems, temporal constraints on individuals and destinations, and the various constraints and limitations that affect individual users. They provide a four-pronged categorization: (1) infrastructure-based, (2) location-based, (3) person-based, and (4) utility-based. Those in the first category deal with service quality along a network, emphasizing travel speeds, congestion, and how well an individual mode facilitates access. The second looks at accessibility from a given location to an assortment of activity sites scattered across a study area, identifying the number of locations within a reasonable travel distance or cost threshold, identical to *cumulative-opportunities*. Person-based measures focus on the activity sites available to a person given individual characteristics that may affect or hinder their movement across an area (e.g., income, disability, age, employment). The last category, the same as one from Handy and Niemeier, consists of studies that take an economic approach to accessibility and consider the benefits or use-value that people derive from a given distribution of activities and how this influences mobility choices.

Lei and Church (2010) added another classification system, focusing measures that analyze transit. They note that transit's characteristics create extraordinary accessibility challenges: a simple shortest-path solution does not work when a network relies on fixed routes, schedules, layovers, and fares, and that people must negotiate these constraints with their own schedules and budgets. In turn, transit-specific measures are classified as measuring either (1) *system accessibility* (whether people can physically access a system and that it is proximate to everyone), (2) *system-facilitated accessibility* (whether a system takes people where they need to go in a reasonable travel time), (3) *integral accessibility* (the total number of opportunities available within a given travel distance or time), (4) *space-time accessibility* (which focuses on individual limits to movement across space vis-à-vis time budgets), (5) *utility-based accessibility* (looking at how consumers weigh travel alternatives and select the one that is most useful), or (6) *relative accessibility* (how well transit compares against rival modes in offering access to the same set of destinations). Even though the latter measures better capture the complexities of transit-facilitated access, they do require substantially more data.

Miller and Harvey (2001), meanwhile, provide a similar tripartite typology: measures that (1) incorporate individual space-time constraints, (2) those that focus on the characteristics of places that make them more or less attractive or accessible (like in a gravity model), or (3) those that measure the benefits and utility that different transport alternatives afford to users vis-à-vis a larger choice set. They advocate for the first category, noting that individuals' access to locations cannot be separated from their available time. In their opinion, a well-functioning system allows all people, regardless of time budget, to feasibly reach demanded destinations. Fransen at al. (2015) alternatively find that existing accessibility metrics ultimately focus on one of four things: (1) *physical accessibility* (people's proximity—in time or distance—to a system), (2) *frequency of transit stops* (the number of trips—or number of seats—available at the stops proximate to a person), (3) *time or cost of travel to a destination*, or (4) *the temporal variability of service* (at a location or over a route during a day, week, or year) relative to people's demands. Each metric builds in complexity over the prior. These measures, like all the categorizations put forth by the authors above, universally agree that, *when the data are available*, more complex measures should be adopted, especially those that consider accessibility as more than just a factor of distance.

The literature applying measures of accessibility to Buenos Aires and other cities in Latin America is small, although growing in recent years. Even though these cities share unique geographies—e.g., massive population growth, pronounced socio-territorial inequalities, rampant poverty, sprawling informal settlements, unequal provision of services, deteriorating public transportation, rapid motorization, paralyzing congestion, inept bureaucracies, and nonexistent planning—the application of advanced accessibility metrics is hindered by poor data quality (Jaramillo et al. 2012). Rather than devising novel approaches for measuring access for their unique urban environments, many papers adopt simplistic *cumulative-opportunities* measures that rely only on more simplistic operationalizations of access, although there are a few that accurately estimates of travel times. The adoption of gravity- or utility-based measurements, meanwhile, is scant.

When it comes to Buenos Aires, Peralta Quiros and Mahndriatta (2015) are a lone exception. The authors actually estimated the number of jobs available to workers from different parts of AGBA within a range of individual travel times. They self-constructed a network-based travel time model that tabulated the number of "employment opportunities" (a vague measurement adopted by the authors, with no explanation of how they estimated employment since, as far as I am aware, these data are not made public by the Argentine government) within sixty-minutes' travel (driving and transit). Performed at a fairly-large scale, the authors calculated access for neighborhood-sized zones across AGBA to get a wide-ranging picture of access, ultimately concluding that its peripheral regions were the most transit-inaccessible. They likewise lamented that most regional growth in the previous decade had taken place in these distant, low-density areas rather than closer to the urban core. Their results do have a few limitations. For one, they do not incorporate actual transits schedules; they are just estimations created by the authors that were incorporated into a geographic information system. They also represent access at an aggregate scale; we cannot see scores for individual parcels or blocks, the spatial scale of the *asentamientos*. It also does not account for diurnal fluctuations in regional travel times brought about by congestion during peak travel times. Nonetheless, this is still one of the few studies of accessibility in Buenos Aires that attempts to incorporate travel time, a model for this paper and an improvement over previous studies of the region.

Looking slightly earlier, Salerno (2012) is an earlier accessibility study that measured access solely as a factor of distance. To diagnose the transit access of the *villas* inside of the City of Buenos Aires, the author calculated the number of transit lines, stops, frequencies, and seats adjacent and available to CABA's *villeros*. Assuming that they would access to their closest stops and lines (via straight-line distance), he found that over 93% of the land area of city, including its precarious settlements, had access to transit. Instead of a strictly-cumulative-opportunities metric, which looks at the occurrences of a feature within a distance, he included just the closest stop or line. While he did incorporate transit frequency data (acquired through a contact at Argentina's transit-statistical agency), the accessibility component was still based only on distance, possibly over-estimating actual conditions. All the while, the study was done at a fine scale, calculating access for disaggregated spatial units similar to the *asentamientos*.

A comparable study was carried out by Arce and Mino (2017) for one of AGBA's outer departments, Jose C. Paz. Using publicly-available train schedules and self-calculated estimations of bus frequencies, the authors discovered that those census blocks (a small unit similar in size to a neighborhood) nearest the department's multiple train stations had the greatest relative supply of transit (across all modes). Like Salerno, they used simplistic distance-based approximations of access to transportation services even while managing to capture accessibility patterns at a disaggregate scale.

Recent papers from Guerra, et al. (2018) and Blanco and Apaolaza (2018) did little to advance the measurement of accessibility in Buenos Aires. The primary objective of the first paper was to uncover predictors of household travel expenditures in AGBA. As such, accessibility was not the main topic of inquiry and nothing more than one of many potential explanatory variables. In fact, this is illustrated by the incorporation of the same flawed access-to-employment opportunities measure created by Peralta Quiros and Mehndiratta (2015) as one of their representations of *accessibility* in their explanatory model. The authors also added a simplistic transit access variable to the mix, tabulating the straight-line distance separating each of metropolitan Buenos Aires' census *radios* (the smallest census-geographic unit that exists in Argentina) and their nearest stop. While the analysis is done at a relatively fine scale, it is problematic for using a potentially-inaccurate employment-access measure and an overly-simplistic transit-access metric that relies only on distance. The second of these papers, meanwhile, barely considered access as part of its goal of evaluating the relationship between limited mobility, socio-economics, and the physical location of Buenos Aires' inhabitants. While they do find that location to be equally as predictive of limited mobility (e.g., longer trip times, infrequent services, long distances from transit, unpaved roads) as income within the conurbation, accessibility itself is not considered beyond the travel times provided by the respondents of the ENMODO origin/destination survey.

Looking beyond Buenos Aires to other urban areas in Latin America, there is a growing body of literature of studies on accessibility and public transportation even though data acquisition concerns remain common. In fact, authors like Bocarejo and Oviedo (2012) and Gutierrez (2014) attribute some of the problems of transportation provision in the region to the lack of data on transportation systems (e.g., commuting patterns, origins/destinations, modal preferences, revenue) and the inability of policymakers to employ complex, accurate measures of accessibility and, therefore, to incorporate observations into comprehensive transportation plans. This is certainly the case for Buenos Aires, where there is little publicly-available, metropolitan area-wide data on critical phenomena like socioeconomics, income distributions, transit schedules, activity sites, employment locations, or geographic information systems. Accurately estimating accessibility, especially as a factor of travel time, is not possible without these data, even if one must fall back on more simplistic cumulative-opportunity estimates.

Such limitations do not exist everywhere, however. Higher-quality data becoming available in more cities. For instance, Guzman, et al. (2017), Rodriguez, et al. (2017), and Hernandez, et al. (2017) could estimate travel times for Bogota, Colombia (the former two) and Montevideo, Uruguay (the latter) using their cities' respective network-routing tools, which permit travel time estimations through their respective transit systems. Delmelle and Casas (2012) and Martinez, et al. (2017), who looked independently at different components of transit-facilitated travel in Cali, Colombia and Santiago, Chile (respectively), could call upon public data on employment and income from their respective census authorities and municipal travel authorities to improve their estimates. Boisjoly, et al. (2017), who looked at employment access in Sao Paulo, Brazil, directly incorporated transit-based travel times from Google. The absence of such tools and data for all of AGBA suggests why the aforementioned studies of accessibility in metropolitan Buenos Aires presented so many limitations. Better information on land use and travel systems in other Latin American cities facilitated more advanced evaluations of accessibility in those cities, whereas the absence of such data in Buenos Aires presupposes accessibility analyses founded on potentially-inaccurate assumptions about employment, income, transport infrastructure, route schedules, and congestion.

Chapter 6: Methodologies

The accessibility analysis carried out by this thesis relies primarily on quantitative methods, although qualitative studies were heavily consulted to inform many critical parameters. To operationalize my adopted interpretation of accessibility (whose selection from the literature I will describe below), I first queried Google Maps' shortest-path routing assignment algorithms to calculate the minimum transit-based travel times between (1) a sample of *asentamientos* from across AGBA and (2) a series of ten important activity sites. I then supplemented these values with a battery of statistical tests to see whether travel times from the *asentamientos* were statistically-significantly different from travel times from a sample of the conurbation's formal neighborhoods.

In the following sections I will describe the Google Distance Matrix API tool and its travel-time calculation process, inputs, parameters, assumptions, outputs, and functional limitations. I will also discuss the important role that the API played in the selection of a modified cumulative-opportunities type accessibility metric. I will then discuss the steps by which I acquired the tools' inputs (e.g., origins and destinations) and how I determined the other parameters (e.g., departure dates and times, modes, etc.) needed for the tool's transit-based travel time queries. Lastly, I will briefly discuss formatting the API's travel-time matrix outputs and how I implemented two different differences-of-means tests: ANOVA and independent-sample t-tests.

Section 6a: Google Maps Distance Matrix API

To calculate transit-based travel times within Greater Buenos Aires, I used Google Maps' Distance Matrix API (Application Programming Interface) web service. This tool allows researchers to determine the shortest-path travel times between different origin-destination pairs, utilizing the same transportation network data and routing algorithm that Google Maps uses to perform on-demand route-finding requests through its web interface (Wang and Xu 2011, p. 200). Shortest-path routing algorithms, like the one used by Google, try to estimate the route between a given origin and destination pair with the shortest travel impedance (time or cost) through a given network. These algorithms are associated with the trip-assignment stage of traditional travel modeling, the step where planners "determine the trip-maker's likely choice of paths between zones … along the network of each mode … and predict the resulting flows … on the individual links [of that] network," (Papacostas and Prevedouros, 2000, p. 400).

According to Google, using an API "gives developers several ways … [for] retrieving data from Google Maps … [with] simple or extensive customization" that, in the case of the Distance Matrix API, "provides travel distance and time from a matrix of origins and destinations … based on the recommended route between start and end points, as calculated by the Google Maps API" (Google 2018).[3] The API, in turn, produces an output that is a travel time matrix indicating the amount of time that Google Maps estimates—based on its proprietary algorithm—required to travel between the origins and destinations input by the researcher.

These estimates depend on one of the API's integral functionalities: its parameters regarding travel mode, arrival/departure times, units, language, and day-of-the-week. When it comes to requesting these data, Google has several interfaces (or "client libraries,") that allow the user to query its servers via well-known programming languages or software packages. I chose the client library created for the statistical programming language R.[4] Per Wang and Xu (2011), R is good at handling large data

[3] https://developers.google.com/maps/documentation/distance-matrix/intro
[4] https://cran.r-project.org/web/packages/gmapsdistance/gmapsdistance.pdf

requests and makes it easy to perform statistical tests once the time values were acquired. The specific tool within R for performing these requests is called "gmapsdistance" and requires an input value for each of the parameters listed above.[5]

The first step required to use the Distance Matrix API tool is to acquire and prepare the data needed for the tool's three fundamental inputs: origins, destinations, and an API key. The origins and destinations are the geographic points representing the starting and ending points for any travel-time analysis. These points can be provided in the form of latitude and longitude coordinates or full addresses. With a standard, free Google account, users are permitted to enter, at one time, no more than twenty-five origins and/or twenty-five destinations. In R, these addresses or latitude/longitude pairs must be entered as a string, or a vector of string values, each separated with a "+".

Google's monitoring and limitation of user activity explains the final required input: the API key. An API key is a unique identifier code that a user must enter into the program before making any requests. Each key is linked to a user's Google account. As a result, they can track and, most importantly, limit the number of requests made to their servers. For the Distance Matrix API, the daily quota is set to 2,500 free elements (where an element is one origin/destination pair), each request may have no more than 25 origins or 25 destinations per request, and requests are limited to 100 per second. Once a user reaches this total for the day, the application will automatically stop returning results.

After the origins, destinations, and API key are set, the user then sets the remaining parameters. These are the mode of travel (driving via the road network, walking via pedestrian paths and sidewalks, bicycling via paths and preferred streets, or

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[5] https://github.com/rodazuero/gmapsdistance

transit via public transit routes), the language and units (metric or imperial) of the output, the arrival and/or departure time (in UTC time), arrival and/or departure date, and the shape of the time table (long or wide). Some parameters are specific to certain modes. If driving is selected, the user can stipulate certain traffic conditions (optimistic, pessimistic, or best guess) or what types of feature to avoid (tolls, highways, or ferries). For transit-based modeling, the user can stipulate specific modes—bus, subway, train, tram/light rail, or rail (a combination of subway, train, and tram)—as well as routing preferences—selecting routes with less walking or fewer transfers (if appropriate). If not stipulated, many of these parameters have a default value: driving as the mode, English as the language, metric as the unit system, and the present day and time for the departure. In R, these parameters are mandatory inputs for the "gmapsdistance" tool and are stipulated as text strings. I will explain my selection of parameters below.

Once the parameters are set, and the tool is run, the final output is a "list with the traveling time(s) and distance(s) between origin(s) and destination(s)." The output table contains a row for each origin and three columns for each destination: one for the distance (in meters), one for time (in seconds), and one that displays a "status" that indicates whether that origin/destination pair calculated correctly ("OK," "NA," "INVALID," and "OVER QUERY LIMIT" are common statuses). The first row and column of the table also contains the latitude/longitude coordinate for the corresponding origin or destination, as entered into the API. Serving as unique identifiers for each row, they allowed me to join these data to foreign tables, shapefiles, and geo-databases.

Given how recently Google Maps introduced its Distance Matrix API web tool (2006), its application within the academic literature is nascent. Nevertheless, researchers have already documented its advantages over alternate methods of estimating network-based travel times. Wang and Xu (2011) compared driving times estimated by the API with those from a network dataset self-constructed within ESRI ArcMap and its network analyst tools (a common alternative approach). Looking specifically at access to hospitals, they found Google's estimates to be *longer* than those from ArcGIS, an indication that the former was realistically accounting for traffic congestion and other possible delays that are more difficult to represent with ArcMap.

On their servers, Google Maps maintains and constantly updates a massive quantity of transportation data on network configurations and characteristics including real-time traffic data, prior congestion levels, speed limits, and restricted turns on urban streets. This permits more accurate and up-to-date estimation of travel times than researchers could feasibly pull together for a custom-built network. Most alternative methods rely solely on speed limits to calculate travel times along road segments and are unable to account for diurnal variations in traffic, a key feature of the API) (Wu 2017).

By deploying the Google Distance Matrix API, the user does not have to collect huge volumes of transportation data or become familiar with complex road and transit network data structures. All the "dirty work" of modeling the network is already done. As noted by Wang and Xu (2011, p. 202), "modeling is as good as the data get," and, in the case of Buenos Aires, Google appears to have the best and most comprehensive data. Nevertheless, it is worth noting some of the API's limitations (per Wang and Xu): the number of requests is limited to users unable to afford a paid license, there is little transparency for non-Google users related to data quality or routing algorithms, and the servers are still prone to returning seemingly-random errors for certain requests (p. 208).

Academic use of the Distance Matrix API specifically for transit-based analysis appears has hereto been uncommon. I was unable to locate any papers that explicitly assess transit-based travel time queries using Google (at least like Wang and Xu's evaluation of drive times), although a bit more has been written about Generalized Transit Feed Specification (GTFS) datasets, the data structure employed and developed by Google for standardizing transit schedules around the world. GTFS, first introduced in 2005, consists of a series of comma-separated value (CSV) files that contain information on a transit agency's name, routes, schedules, frequencies, stop locations, shapes, transfer points, and fare attributes. Regardless of an agency's size or location, each of these files uses the same simple, open-source formatting; this helps to "facilitate data sharing and access to information" and to be easily operable with online applications that provide route and schedule information to transit users (Fortin et al. 2016, p. 22).

GTFS has become standard within transportation departments in the United States and, increasingly, around the globe. Recent innovations have made GTFS datasets interoperable with GIS programs like ESRI ArcMap, permitting users to more accurately study and produce "service area calculations, … time and distance service calculations, stop location and spacing optimizations, [and] service frequencies" (Fayyaz et al. 2017, p. 5). Additionally, when looking specifically at transit, the GTFS schedule estimator is easily paired with calculations of the walking distances and times required for users to reach their nearest transit stop and/or make any transfers between routes (Wu 2017).

Two studies (Fortin et al. 2016; Wu 2017) however acknowledged shortcomings of GTFS and the transit travel time estimates derived from it. The constituet data files are susceptible to data-entry errors or network "misrepresentations" (e.g., stops or routes with incorrect coordinates) and the schedules are, in fact, schedules and not innately able to account for real-time traffic delays or service disruptions. Furthermore, since Google does not publicly disclose its routing algorithm or procedure for estimating travel times, it is difficult to verify their claims (Wu 2017). There is a need for academic research that validates the accuracy of Google's transit-based travel time estimates, and these limitations are acknowledged as potentially affecting my results.

In terms of applying Google Maps' web tools to questions of transit in metropolitan areas in Latin America and the Global South, there is some precedent. Boisjoly et al. (2016) used the Distance Matrix API to estimate travel times between residences and employment sites in Sao Paulo, Brazil. More specifically, they queried the API for transit-based travel times for trips that left their stipulated origins at 7am (during the metro area's peak travel hour) and minimized transfers. All of these were made possible by the conversion of Sao Paulo's transit schedules into GTFS, a process that is similarly ongoing in Buenos Aires. The authors do note, however, the risks of using a single departure date and time in their study: greatly different outcomes can result from small shifts in departure time. Such differences, however, are not as important when diagnosing access at an aggregated, metro-level scale, they claim (p. 91). Knowing that my technique was used to analyze accessibility in a similarly-sized Latin American conurbation to metropolitan Buenos Aires adds confidence to my application.

As a matter of fact, Google is quite likely the most authoritative source for travel data in agglomerated Buenos Aires. According to a 2016 article from *La Nacion*, one of Buenos Aires' primary newspapers, Google worked extensively with the governments of CABA and the departments of AGBA to acquire all the transit schedules needed to allow local travelers to request transit-based directions (with corresponding estimates of travel time, distance, and cost) through Google Maps' web and mobile applications. According to the article's author, Google collected schedules from an array of government agencies: CABA's municipal government, the federal transport ministry, Ferrovías (a private company operating one of Buenos Aires' commuter rail lines), Metrovías (another private company operating CABA's subway system), and CNRT (government agency for transport statistics), and other private enterprises (presumed to be the operators of major bus lines). Altogether, they collected data on 800 routes and 34,000 stop locations. Argentine public users gained access to this information—through the Google platform—in early 2016, following the lead of 18,000 other cities in 70 countries from around the world (Tomovose 2016). Combined with existing roads datasets, users could now request directions for driving, walking, and transit between any two points in the conurbation.

The incorporation of transit into Google Maps' directions tools in Buenos Aires presupposes that Google converted the schedule data collected from the different local agencies and companies into GTFS format. Since these datasets have not been made public (as would be the case for transit agencies in the United States), it is impossible to know for sure or to check their quality. It is also impossible, for instance, to know when they were most recently updated or if they fully represent all modes of formal and informal transportation in the metro area. There is little to no publicly available official information on transit schedules for routes within the AGBA's departments outside of the City of Buenos Aires. In contrast to the other governments in the region, CABA operates its own travel-time route estimator (*ComoLlega*) for requests within its boundaries, and it publishes GTFS files for its bus and subway routes. The only exceptions to the lack of transportation data transparency across the metropolitan area are printed time tables for the individual commuter railway lines. Otherwise, given that so much is not publicly-known about the operations of AGBA's public transportation system, it naturally forces one to ponder how exactly Google was able to cajole these data from existing operators, some of which are colloquially said to not even follow exact schedules, operate along informal schedules or headways, or run routes without dedicated stops.

As it would be virtually impossible to self-construct a network dataset using publicly-available data in the conurbation, I am essentially forced to call upon the Google Distance Matrix API in my pursuit of accurate travel time-estimations for the region. By using these reasonably accurate public transit travel time estimates, this thesis is immediately more advanced than any of the prior accessibility studies on AGBA.

Given its leading role in this thesis' analysis, the Google Distance Matrix, and its noted limitations, ultimately dictated which types of accessibility measurements I could adopt. In particular, the strict quotas placed on origin/destination requests made it difficult to implement a true *cumulative-opportunities measure*, as was intended. These measures, which are also known as "contour" or "isochrone" accessibility measures, are centered on the "degree to which two places or points on the same surface are connected" and measure "the number of opportunities which can be reached within a given travel time, distance, or cost, or the measure of the (average or total) time or cost required to access a fixed number of opportunities" (Geurs and Van Wee 2004, 133). Their advantage is that they are quickly operationalized, easily interpretable, and relatively undemanding of data. Little outside knowledge of accessibility dynamics is needed as is often required for complex utility- or gravity-based calculation.

Still seeking to take advantage of the ease of communication that characterizes these measures, I opted for a hybrid measure: a simplified cumulative-opportunities measure that simultaneously accounts for *system-facilitated accessibility*, or whether certain destinations can be reached specifically via public transportation (Lei and Church 2010). Instead of tabulating the number of destination sites within a given transit-based travel time threshold, I looked to identify the minimum transit-facilitated travel time that a person living in any *asentamiento* would need to reach any occurrence of a given amenity. In some cases, there are over a thousand locations for some feature classes (e.g., schools, health centers) and calculating the travel time to each of them would require a huge number of requests. In the interest of time and the desire to examine accessibility from *asentamientos* in multiple parts of AGBA, I looked at just the travel time to each *asentamiento's* "nearest neighbor" within each feature class. Rather than measuring *cumulative* opportunities, this thesis, it could be said, measures *singular* opportunities.

While it is true that identifying only the nearest activity site to an origin fails to incorporate individual perceptions or preferences, assuming all locations are equally desirable to all people ignores that certain sites may be more attractive than others even if farther away, calculating the travel times to all features in an activity class is unfeasible with the API quotas. With unlimited access, as well as more detailed information on the attractiveness of different destination sites, perhaps a more complex accessibility metric could be adopted using the tool. Similarly, accounting for daily and weekly variation in transit schedules, another common criticism of cumulative-opportunity measures, is also challenging since separate requests are needed to capture any variation in departure date or time. While specific time and date parameters are selected (and justified using background information on the *asentamientos*), findings that account for diurnal and weekly variations are only possible with expanded access to the API tool.

Section 6b: API Parameter for Origins

Selecting API-compatible origin coordinates for the *asentamientos*, was an intricate task. I began by visiting the TECHO website and downloading—from their interactive online map—a shapefile of all informal housing neighborhoods in Argentina.[6] Once uploaded into ArcMap, I selected, from this file, only those settlements classified as *asentamientos* and that were also located in one of the thirty departments of AGBA. This yielded a total of 687 units (see **Figure 4.2**). Compare these results with the socio-economic indicators (**Figure 2.7a-b)** and population density (**Figure 2.6**) and see how most *asentamientos* are in underdeveloped, low-density parts of AGBA.

While it made initial sense to use the center-points of these polygons as the "origin" points of my API matrix requests, knowing the travel times from these neighborhoods is useful only for understanding *absolute* accessibility. Without some type of comparison points, limiting my requests to just the *asentamientos* would provide me only with their accessibility levels *relative to each other* and not give any indication as to whether they enjoy greater or lesser transit accessibility relative to people who live outside of the *asentamientos*.

As a result, I needed a new unit of spatial analysis that could permit the selection of a "control" group of traditional neighborhoods to compare against the *asentamientos*. There is no immediate solution to this problem because the *asentamientos* vary greatly in shape and size and, therefore, do not universally align with any preexisting spatial or

[6] http://relevamiento.techo.org.ar/

geographic administrative units. Nonetheless, I ultimately gravitated towards the census geographies created by INDEC as part of the 2010 Argentine national census (shown in **Figure 6.1**). The smallest unit of analysis from the census—known as the *radio*—turned out to be the best option. For reference, groups of radios are nested inside of "*fracciones*" (fractions), which are, in turn, further nested inside of the departments.

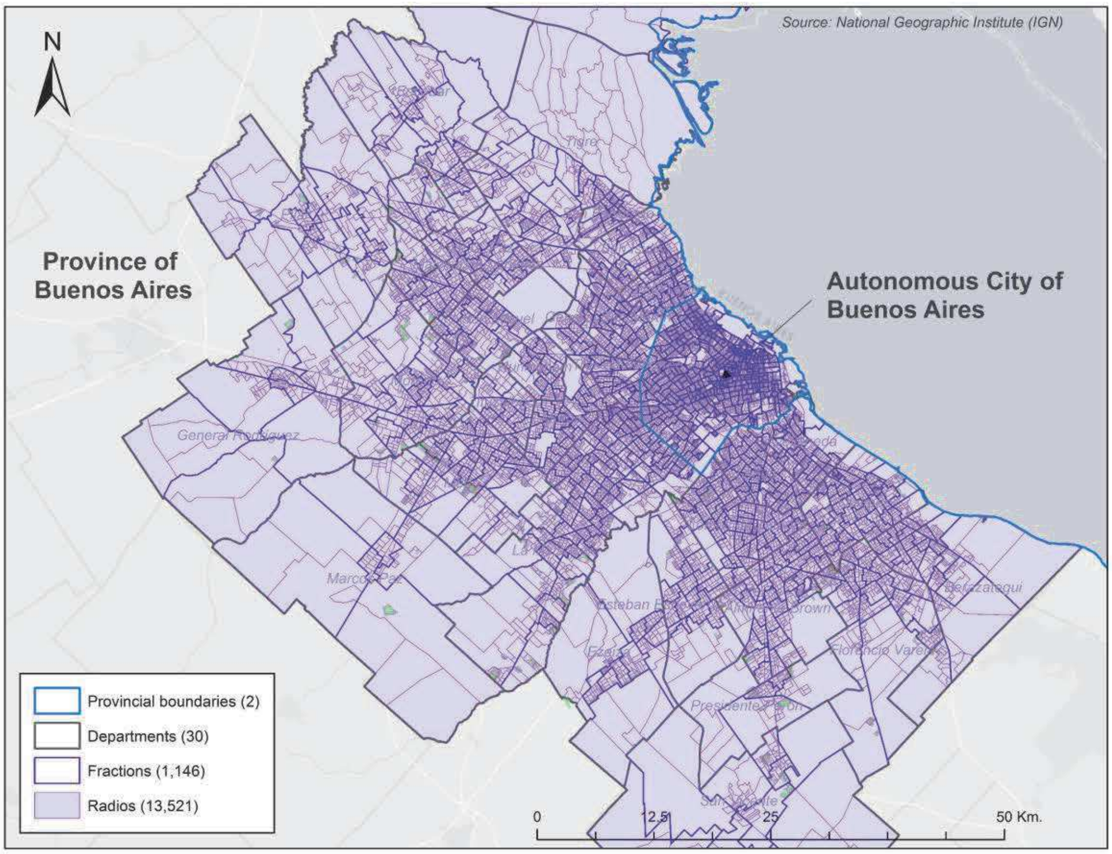


Figure 6.1: Map of all census geographic units in Agglomerated Buenos Aires (AGBA), including provinces, departments, fractions, and radios (2010)

Roughly equivalent to the "block" unit within the United States, census *radios* are quite small, often a few city blocks in size. While *asentamientos* rarely overlap perfectly with individual census radios, they are often similar in size (see **Figure 6.2** for examples from La Matanza and Merlo departments). This allows census radios, based on their degree of overlap with an *asentamiento*, to be a nominal stand-in for many of my study sites. Since the entire study area is covered with radios (there are 13,521 in AGBA alone), it is possible to draw a sample of non-overlapping radios to compare against those that contain part of an *asentamiento,* which was the approach I eventually took. Furthermore, INDEC publishes a robust amount of data—through the 2010 census—on demographic and household characteristics at the radio-level, which I could compare against the travel time results to see if any statistically-significant correlations exist.[7]

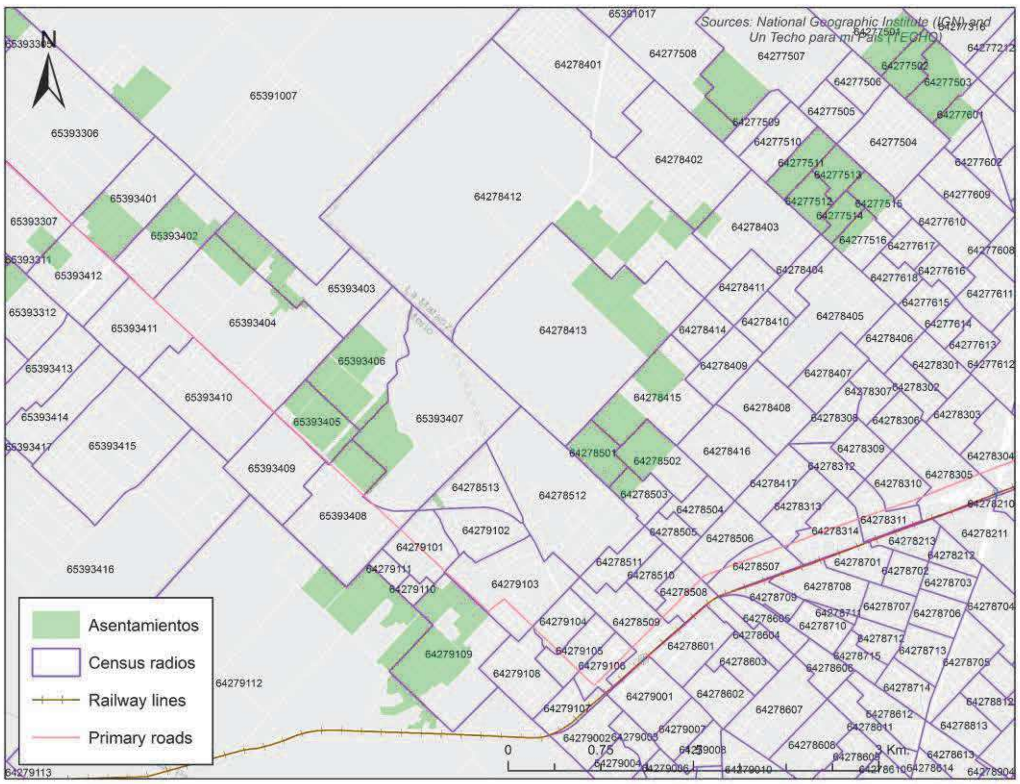


Figure 6.2: Map of *asentamientos* from La Matanza and Merlo departments, overlaid with census radios to show relative overlap (2013)

In turn, I used ArcGIS to calculate the degree to which each of those 13,521 radios overlapped with the 687 *asentamiento* polygons. Given the relative dispersion of

[7] Data include: housing density, land ownership types, roof quality/material, possession of a bathroom, flushing toilets, sewerage, cooking heat type, floor quality/type, clean water availability, computer ownership, freezer ownership, landline ownership, cell phone ownership, literacy, age, employment, education level, age cohorts, gender, national origin, quality of services, construction quality, housing material quality, housing occupation, and housing type (INDEC 2011).

asentamientos across the metro area, it is hardly surprising that the average overlap was only 1.98% and that over 94% of all radios registered no overlap at all (12,700 of 13,521). Conversely, nine recorded total overlap (100%) and 821 saw more than 1% of their territory covered by an *asentamiento.* **Figure 6.3** depicts all AGBA census radios, colored by their degree of overlap.

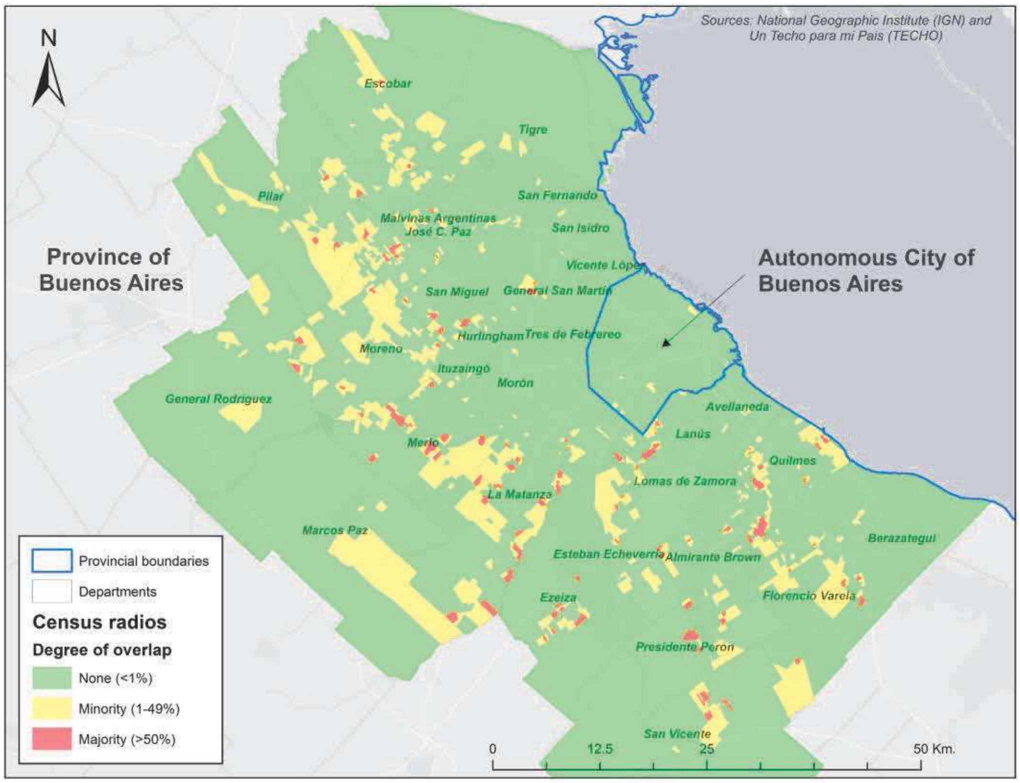


Figure 6.3: Map of census radios in Agglomerated Buenos Aires, colored based percent overlap with an *asentamiento* (2013)

To create separate study and control groups for this project, I grouped the census radios by: (a) those that overlap with an *asentamiento,* and (b) those that did not. Furthermore, I subdivided the study group into "majority" (greater than 50% of territory overlapped by an *asentamiento*) and "minority" (between 1% and 50% overlap) groups; 206 fell into the former and 615 in the latter. Summary statistics on the overlap calculations, per district and agglomeration level, are included in **Table 6.1**. With unlimited time, I would have begun my API queries here, requesting travel time information for each of these *radios*. However, as was noted before, standard Google accounts are only allowed 2,500 free origin/destination API requests per day. Performing travel time requests for all these origins, even with a singular destination, was not feasible given time and budget constraints, forcing me to narrow my scope even more.

Table 6.1: Summary statistics of the departments of Agglomerated Buenos Aires (AGBA), as they relate to and overlap with the *asentamientos* (2013)

Department	% of population in AGBA	% of *asentamientos* in AGBA	No. of families in *Asentamientos*	Radios	Avg. Overlap	Radios, by Overlap			Agglom., Class (2003)
						Maj.	Min.	None	
C.A. Buenos Aires	**21.55%**	**0.00%**	**0**	**3,555**	**0.00%**	0	6	3,549	*CABA*
Quilmes	4.33%	7.40%	19,995	557	4.29%	*6*	*1*	*80*	*GABA, Totally Agglom.*
José C. Paz	1.98%	4.48%	6,575	218	6.00%	0	35	5	
Malvinas Argentinas	2.40%	3.44%	3,495	281	2.43%	2	0	49	
Lomas de Zamora	4.58%	2.93%	11,440	612	2.44%	14	9	79	
San Miguel	2.05%	2.93%	7,642	256	4.75%	12	6	28	
Ituzaingó	1.25%	2.07%	819	160	0.92%	0	9	51	
Hurlingham	1.35%	1.89%	3,011	170	0.48%	0	6	164	
Avellaneda	2.55%	1.20%	2,305	387	0.24%	0	5	382	
General San Martín	3.08%	1.03%	6,245	435	1.93%	8	7	420	
Lanús	3.41%	0.86%	2,200	517	0.78%	3	6	508	
Morón	2.39%	0.52%	125	357	0.02%	0	2	355	
San Isidro	2.18%	0.52%	320	320	0.15%	0	3	317	
Tres de Febrero	2.53%	0.34%	315	377	0.06%	0	1	376	
Vicente López	2.00%	0.00%	0	344	0.00%	0	0	344	
Zone 1	**57.62%**	**29.60%**	**64,487**	**4,991**	**1.75%**	**63**	**200**	**4,728**	
La Matanza	13.20%	11.88%	34,681	1,302	3.09%	*36*	*65*	*1,201*	*GABA., Partially Agglom.*
Moreno	3.36%	11.36%	18,423	389	3.09%	4	57	328	
Florencio Varela	3.17%	8.26%	17,925	360	6.74%	20	46	294	
Merlo	3.93%	7.92%	19,490	453	6.69%	28	43	382	
Almirante Brown	4.11%	3.79%	11,040	484	2.61%	10	28	446	
Esteban Echeverría	2.24%	3.27%	13,800	254	2.56%	4	16	234	
Tigre	2.80%	2.75%	2,920	320	0.71%	0	19	320	
Ezeiza	1.22%	2.07%	10,020	146	8.83%	12	14	120	
Berazategui	2.41%	0.52%	460	290	0.37%	1	3	286	
San Fernando	1.21%	0.34%	520	164	0.59%	1	1	162	
Zone 2	**37.64%**	**52.15%**	**129,279**	**4,162**	**3.44%**	**116**	**292**	**3,754**	
Greater Buenos Aires	**95.26%**	**81.75%**	**193,766**	**12,708**	**1.82%**	**179**	**498**	**12,031**	
Pilar	1.73	6.02%	13,170	279	3.45%	*6*	*40*	*233*	*Non-GABA, Partially Agglom.*
Escobar	1.32	3.79%	7,980	194	3.69%	3	28	163	
General Rodríguez	0.65	3.61%	5,178	113	4.86%	3	29	81	
San Vicente	0.33	2.58%	4,685	83	0.56%	4	11	68	
Presidente Perón	0.45	1.55%	6,780	73	13.50%	11	6	56	
Marcos Paz	0.32	0.69%	2,340	58	0.62%	0	3	55	
Zone 3	**4.80%**	**18.24%**	**40,133**	**800**	**4.64%**	**27**	**117**	**656**	
Agglom. Buenos Aires	**100.0%**	**100.0%**	**233,899**	**13,508**	**1.98%**	**206**	**615**	**12,687**	

Sources: Instituto Nacional de Estadísticas y Censos (2010) and TECHO (2013)

While there are *asentamientos* across Buenos Aires' metropolitan periphery, I selected just three of these departments (highlighted in purple in **Table 6.1**) as case studies. Seeking to produce results that would apply to the largest number of *asentados* as possible, I prioritized departments by the number of families residing in their respective *asentamientos*, eyeing those with the largest values in the fourth column of **Table 6.1**. When these raw data are mapped, however, the districts with the most *asentados* are all on AMBA's western side (La Matanza, Moreno, Merlo) and off to the southeast (Quilmes and Florencio Varela)—see **Figure 6.4**. This distribution corresponds to general socio-economic patterns in AGBA and their north/south gradations.

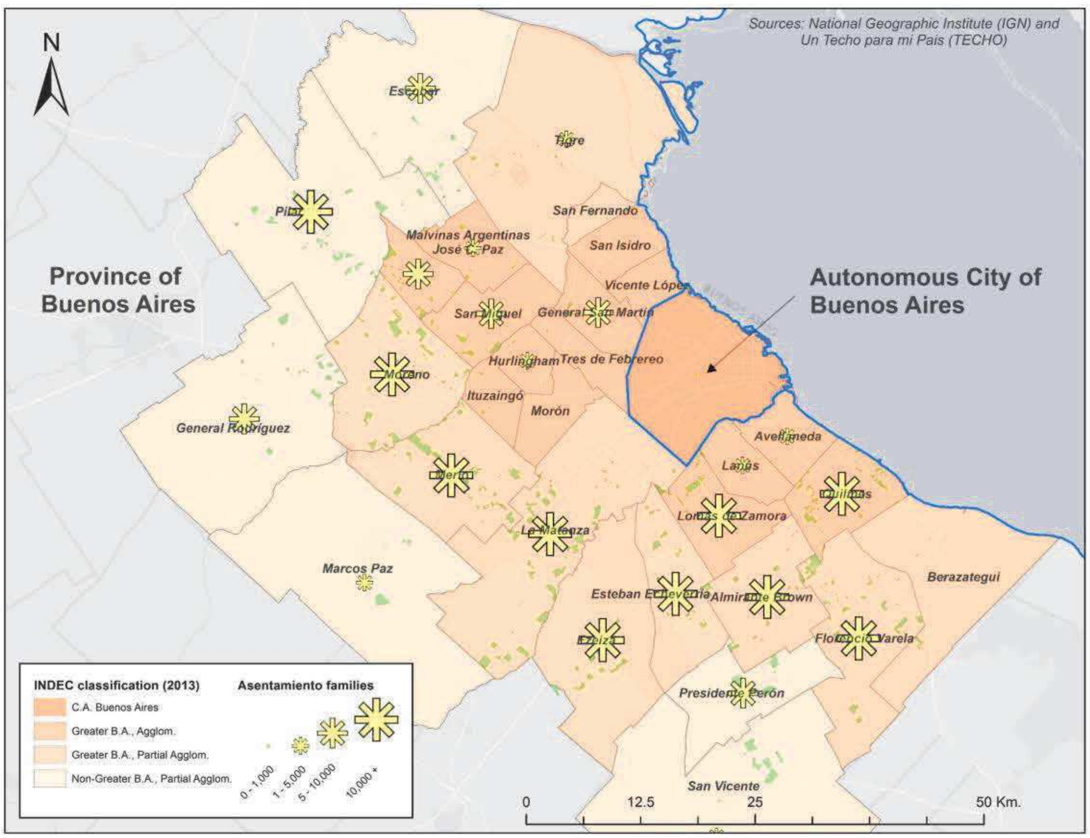


Figure 6.4: Departments of Agglomerated Buenos Aires (AGBA),
by number of families estimated to be living in *asentamientos* (2013)

While selecting these five would account for accessibility conditions among a large proportion of the conurbation's total population of *asentados*, it could miss trends in some of the other districts, especially those further removed from CABA's core. As a result, I added one additional step. I categorized the departments using INDEC's urbanization hierarchy mentioned at the beginning of the paper (**Figure 2.5** and **Table 2.1**). Considering that each of these categories represents departments of varying degrees of urbanization (and therefore exhibiting different densities, infill, age of development, and dispersion of services), selecting radios from each provides a snapshot of accessibility as it relates to each of AGBA's urban and suburban zones.

With this categorization set, I selected the department from each group with the largest population of asentamiento families (a statistic tabulated by TECHO during their survey): Quilmes (GABA + total agglomeration; 19,995 families in 43 communities), La Matanza (GABA + partial agglomeration; 34,681 in 69), and Pilar (non-GABA + partial agglomeration; 13,170 in 35). Shown on **Figure 6.5**, these departments are spatially distinct, each representing districts of varying age and development (Quilmes the most established, Pilar the youngest, and La Matanza in between) as well as Buenos Aires' socioeconomically distinct edges: the historically wealthy north (Pilar), the working-class west (La Matanza), and the impoverished south (Quilmes). Maps of these districts, and their asentamientos (shown in **green**), are provided in **Figures 6.6**, **6.7**, and **6.8**. Nonetheless, the number of census radios comprising each of these districts (**Table 6.2**) was still massive. I had to perform one last sub-sampling to reduce the number of origins to numbers compatible with the API's strict quotas.

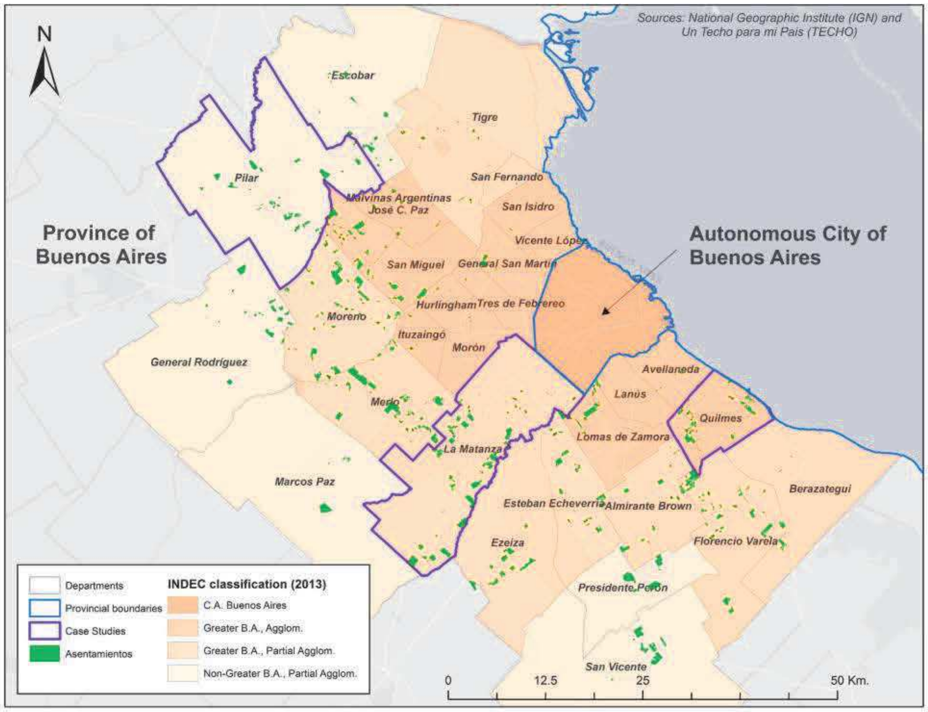


Figure 6.5: Departments of Agglomerated Buenos Aires (AGBA), highlighting the three selected as case studies: La Matanza, Pilar, and Quilmes

To complete this task, I performed a series of stratified random samples on the census radios belonging to each case study. For all three districts, I began by dividing their radios into those classified as "majority overlap," "minority overlap," and "no overlap." **Table 6.2** summarizes the number, and percentage, in each category.

Table 6.2: Summary statistics of three case study departments, by overlap with their respective *asentamientos* (2013)

	Radios			Overlap			
District	Radios, Total	Average Overlap	Avg. Pop., per Radio	Majority (% of All)	Minority (% of All)	Any (% of All)	None (% of All)
Quilmes	557	4.29%	1,047	16 (2.9%)	61 (11.0%)	77 (13.8%)	480 (86.2%)
La Matanza	1,302	3.09%	1,364	36 (2.8%)	65 (5.0%)	101 (7.8%)	1,201 (2.2%)
Pilar	279	3.45%	1,072	6 (2.2%)	40 (14.3%)	46 (16.5%)	233 (83.5%)
Totals	**2,139**	**3.45%**	**1,234**	**58 (2.7%)**	**166 (7.8%)**	**224 (10.5%)**	**1,914 (89.5%)**

Sources: Instituto Nacional de Estadísticas y Censos (2010) and TECHO (2013)

To select my study groups, I first randomly selected thirty radios from all three districts' populations of majority-overlap and minority-overlap radios. When there were not thirty available, I included all applicable radios. Once these were identified, I then added together the number of majority- and minority-overlap radios, per case study, into a secondary categorization called any-overlap. I then drew a random sample from the no-overlap radios from each district, selecting a sample of the same size as the number of radios in each district's any-overlap category. Because the pool of no-overlap radios was consistently much larger than those with any-overlap, and I wanted to ensure I was drawing a proportionally-representative sample of no-overlap radios to match those drawn for the other two categories. The sample sizes drawn for each category of radios are included in **Table 6.3**; notice how the no-overlap samples (fifth column) represent only a relatively small percentage of their respective populations.

Table 6.3: Sampled census radios, by *asentamiento*-overlap, drawn from all three case studies (2013)

District		Radio-Overlap Categories				
		Majority (% of All)	Minority (% of All)	Any (% of All)	None (% of All)	Total (% of All)
Quilmes	Sample	16 (100.0%)	30 (49.2%)	46 (59.7%)	46 (9.6%)	**92 (16.5%)**
	Radios	16	61	77	480	**557**
La Matanza	Sample	30 (83.3%)	30 (46.2%)	60 (59.4%)	60 (5.0%)	**120 (9.2%)**
	Radios	36	65	101	1,201	**1,302**
Pilar	Sample	6 (100.0%)	30 (75.0%)	36 (78.3%)	36 (15.5%)	**72 (25.8%)**
	Radios	6	40	46	233	**279**
All 3	Sample	52 (89.7%)	90 (54.2%)	142 (63.4%)	142 (7.4%)	**284 (13.0%)**
	Radios	58	166	224	1,914	**2,183**

Sources: Instituto Nacional de Estadísticas y Censos (2010) and TECHO (2013)

Figures 6.6-8 are maps of each case study, showing the sampled radios.

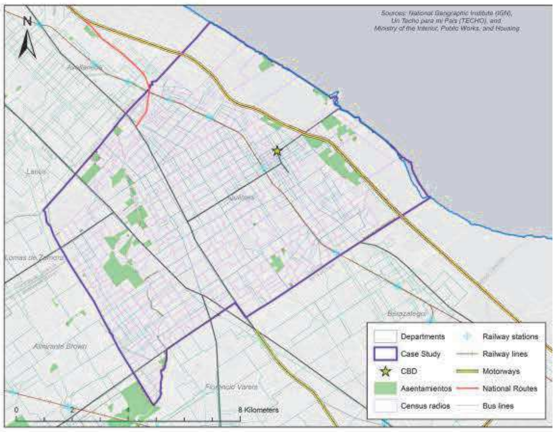


Figure 6.6a: Locations of *asentamientos* and transportation infrastructure, Quilmes department

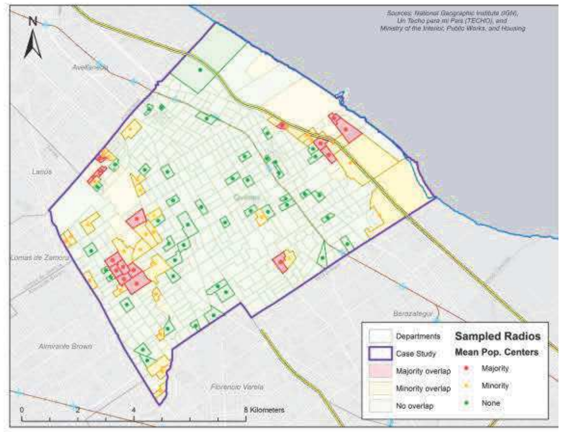


Figure 6.6b: Sampled census radios (by degree of overlap with *asentamiento*), Quilmes department

In Quilmes, *asentamientos* are all either along the Buenos Aires-La Plata freeway (to the northeast) or along the *Arroyo Piedras* creek.

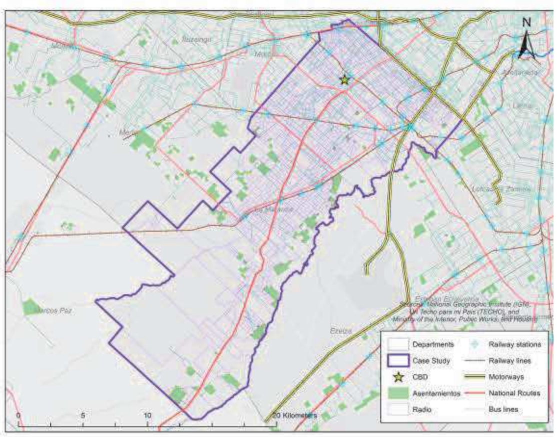


Figure 6.7a: Locations of *asentamientos* and transportation infrastructure, La Matanza department

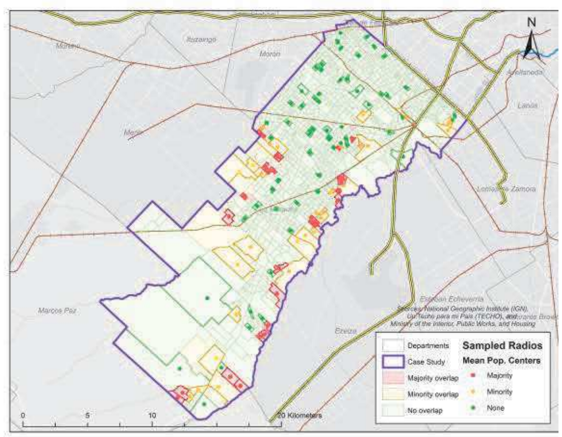
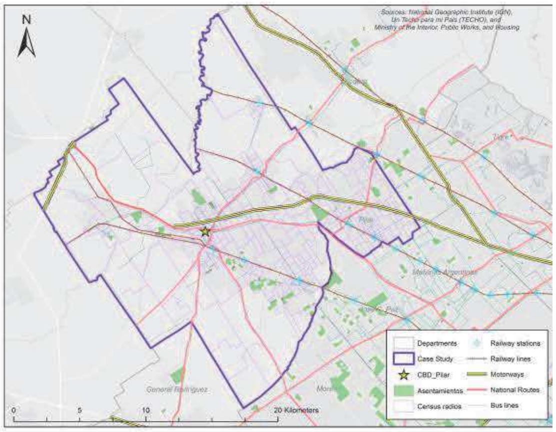


Figure 6.7b: Sampled census radios (by degree of overlap with *asentamiento*), La Matanza department

In La Matanza, *asentamientos* are exclusively in its southern half, either along (a) its northwestern border with Moron and Merlo departments or (b) its southeastern boundary with Ezeiza and Lomas de Zamora. The latter of these two borders is defined by the *Riachuelo*, a heavily-polluted river that cuts through former industrial areas.



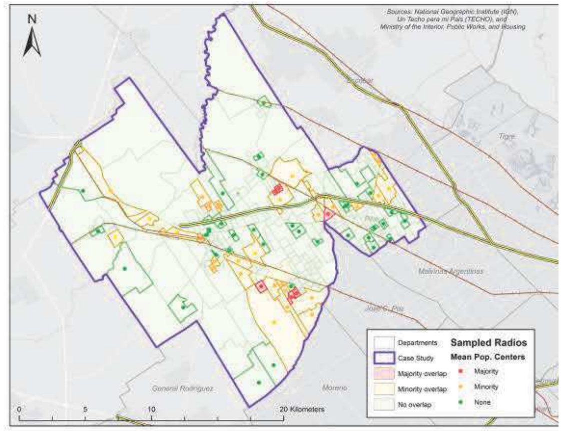


Figure 6.8a: Locations of *asentamientos* and transportation infrastructure, Pilar department

Figure 6.8b: Sampled census radios (by degree of overlap with *asentamiento*, Pilar department

In Pilar, *asentamientos* are closer to its geographic center, with small pockets in all directions from its central business district (star on **Figure 6.8a**).

Table 6.4 contains some census statistics, ENMODO results, and TECHO interview findings for all three of these districts. Each of the included variables represents a characteristic traditionally associated with the *asentamientos*. La Matanza has the largest overall population, and, in fact, is the most populous department in AGBA outside of CABA. Note how Pilar scores the worst in many development indicators (piped water, sewerage, basic needs unmet, illiteracy, bus trips, and school attendance) yet also has the highest rates for university attendance, car ownership, trips by auto, and homes in gated communities: inequities are discernable even at the aggregate district scale. Also note how, paradoxically, Pilar's *asentamientos* scored the worst is nearly all access metrics except for "percent of *asentamientos* with public transit inside the neighborhood." This finding was ultimately more of a harbinger of this thesis' results than initially expected.

Table 6.4: Summary of *asentamiento*-related demographic variables, pertaining to all three case study departments

Source	Variable	Quilmes	La Matanza	Pilar	AMBA
INDEC, 2010 census	Total population (% of AMBA)	520,552 (4.0%)	1,398,891 (10.8%)	266,564 (2.5%)	12,985,885 (100.0%)
	People per radio	1,047	1,364	1,072	1,006
	Homes per radio	327	344	335	345
	% homes with *"basic needs unmet"*	8.8%	11.4%	11.8%	9.1%
	% homes, owner does not own land	5.4%	4.9%	4.4%	4.9%
	% homes, public network sewage	61.6%	47.2%	18.6%	56.0%
	% homes, piped water inside home	92.4%	85.5%	79.7%	91.0%
	% people, illiterate	5.5%	5.9%	6.7%	5.1%
	% people, never attended school	2.0%	2.5%	2.7%	1.8%
	% people, attended university	10.7%	6.3%	10.0%	14.0%
	% people, born in Argentina	92.7%	90.8%	93.1%	91.5%
	% homes, "insufficient" services	25.7%	36.0%	65.2%	30.4%
	% homes, "insufficient" const. quality	14.4%	19.7%	22.7%	12.4%
ENMODO respondents, 2009-10	Trip generation rate	1.4	1.5	1.5	1.5
	Average people per home	3.1	3.5	3.8	3.2
	Homes, average income quintile	2.9	2.6	2.5	2.9
	% homes, *villa de emergencia*	4.0%	2.3%	2.7%	2.3%
	% homes, gated community/country	0.1%	0.1%	8.4%	0.4%
	% homes, with automobile	36.1%	35.1%	38.3%	36.9%
	% people, employed as domestic help	2.2%	3.0%	3.2%	2.6%
	% people, attending school	9.0%	9.3%	10.0%	9.3%
	% students, public school	67.9%	73.1%	69.0%	70.4%
	% students, private school	32.1%	26.9%	31.0%	29.6%
	% people, actively working	39.6%	39.1%	37.5%	40.9%
	% people, working in private sector	36.2%	37.0%	34.0%	37.7%
	% people, working in public sector	4.9%	3.8%	4.0%	4.5%
	% trips, made 5x weekly	57.8%	24.1%	58.9%	53.3%
	Most common hour of trip departure	12:00 PM			
	% trips, on bus	43.4%	45.9%	23.4%	39.4%
	% trips, on rail	3.8%	2.9%	7.9%	7.1%
	% trips, in private auto	19.1%	15.6%	27.4%	17.9%
	% trips, on foot	23.6%	25.7%	28.9%	23.5%
TECHO, 2013	% asent., irregular electricity access	69.0%	71.6%	50.0%	62.4%
	% asent., water from public network	11.9%	16.4%	0.0%	4.8%
	% asent., firewood/coal for heat	9.5%	14.9%	26.7%	12.8%
	% asent., ambulance always responds	71.4%	25.4%	60.0%	45.3%
	% asent., floods with every rain	42.9%	31.3%	53.3%	35.2%
	% asent., hospital beyond 5km	35.7%	59.7%	63.3%	54.0%
	% asent., public transit inside neigh.	23.8%	13.4%	36.7%	19.8%
	% asent., major prob., service access	33.3%	34.3%	20.0%	29.4%
	% asent., public sewerage	7.1%	1.5%	0.0%	3.3%

Sources: INDEC (2010), Secretaría de Transporte (2011), and TECHO (2013)

After conducting my samples, reducing my pool of origins down to 284, the only other step was to convert these census radios, which are polygons, into points (with latitude and longitude coordinates) that could be fed into the API interface. Simply using the polygons' centroids was problematic, especially for spatially-expansive radios like those in Pilar and La Matanza. For these instances, there was a risk that the center point would be far from the population of people actually living in that radio.

I subsequently crafted my own solution to this problem. I first visited the website of the Socioeconomic Data and Applications Center (SEDAC) at Columbia University, where there is a repository of geospatial data on world population distributions. [8] From the available SEDAC files, I acquired a raster dataset of the estimated distribution of people throughout Argentina. These data, calculated by SEDAC using custom interpolation techniques ("random forest classification and regression"), depicts "likely residence locations at a 100-meter scale" (Rodriguez et al., 2017, pp. 36–37)." Their results for 2015, trimmed to the surface area of Agglomerated Buenos Aires, are shown in **Figure 6.9,** along with the three case studies.

[8] http://sedac.ciesin.columbia.edu/data/collection/gpw-v3

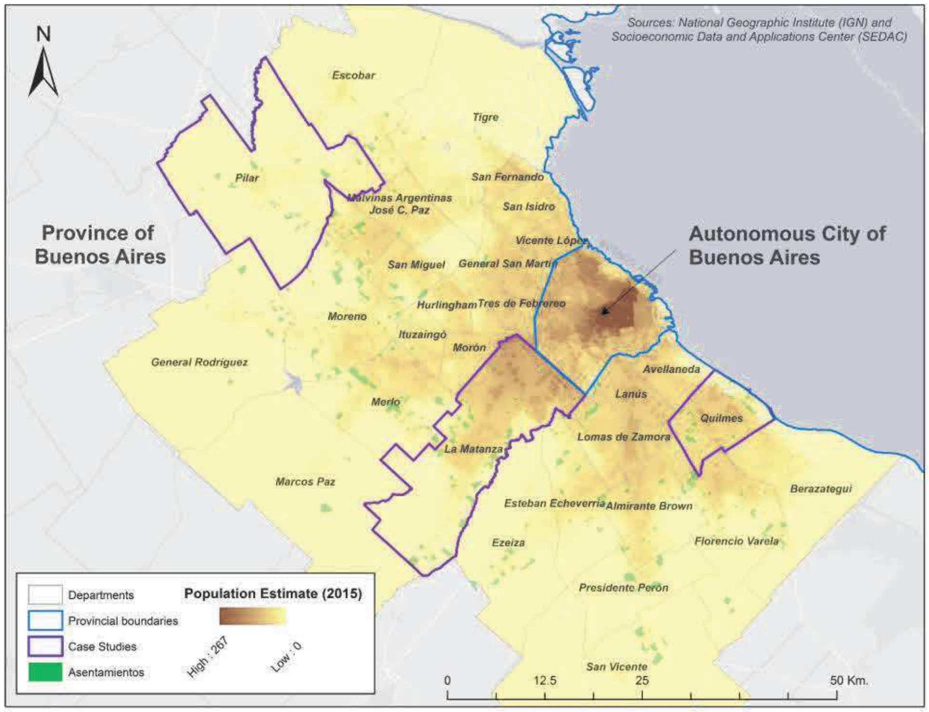


Figure 6.9: Departments of Agglomerated Buenos Aires (AGBA), overlaid with SEDAC population estimates (2015)

From this raster, I extracted the surfaces corresponding to each case study and then converted the raster into a point field. One point was placed at the center of each 100-meter raster cell, assigned the value of the corresponding raster grid cell. I then used a spatial join to identify the specific census radio to which each point belonged before then calculating the weighted mean population center for each census radio. The result was a series of points corresponding to the weighted mean population centers of each census radio, shown on the map in **Figure 6.10** below. By using these specific points, I am ensuring that the "origins" entered into the API correspond to actual residences.

The only other step was to calculate the X/Y coordinate for each point, an easy process in ArcGIS. To make sure these values were compatible with the Distance Matrix API, I created a special column in the attribute table called "YX coordinate" where the coordinate was stored in the proper text-string format ("Longitude+Latitude", for example: "-34.7098979561128+-58.2342871680724"). I then exported, for each district, its list of points as a CSV, which could then be easily imported into R to serve as the origins input for gmapsdistance API requests.

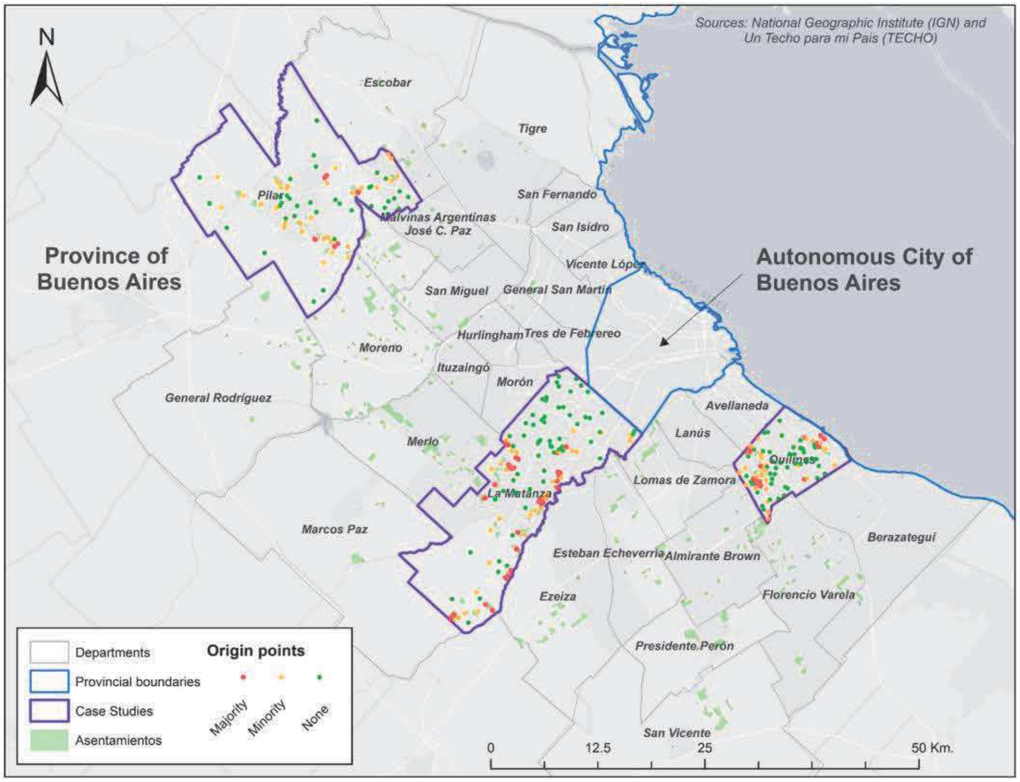


Figure 6.10: Weighted mean population centers of sampled census radios, by overlap with an *asentamiento* (2013) and from all three case studies

Section 6c: API Parameter for Destinations

Acquiring the coordinates of the destinations was more straightforward. Heeding the advice of Handy and Niemeier, I sought datasets representing the likely activity sites for metropolitan Buenos Aires' *asentados*. To do this, I returned to the qualitative and quantitative sources discussed earlier: TECHO's surveys, INHABITAT's interviews, and ENMODO's travel survey statistics. Unfortunately, none of them directly asked *asentados* transit-specific questions about travel times or destinations. It is known, however, that buses are the most common mode of travel, that most respondents had transit within a short distance of their settlement, schools, clinics, and jobs were relatively close, and hospitals and recreation centers were more distant. Whether transit is favored for certain trip types or destinations, however, remains a mystery, with nothing to prioritize any one feature for inclusion with the API. The lack of detailed travel behavior information prevented exploring the unique mobility patterns and destinations associated with particular subsets of the *asentado* population, namely women and children.

Since the purpose of this project is ultimately comparative (looking at differences between the *asentados* and their "legal" neighbors), I used the ENMODO survey as an initial guide because it summarized trips by all travelers. The most common destination was work (37%), followed by education/accompanying someone to school, (34%), shopping (7%), personal business (5%), health (4%), family (3%), and recreation (2%) (Secretaría de Transporte 2011). I looked only for destination types that could be represented by geospatial datasets with reliable point-data for the entirety of AGBA. If location data for a given activity site was only available for a part of the study area, or if it was inconsistently depicted across the whole region, it was discarded. This proved difficult given the paucity of public geospatial data available from national, provincial, and municipal governments in Argentina. While CABA has a well-maintained repository of GIS layers, they are all inapplicable to the suburban scope of this project. Ultimately, I located comprehensive data for only schools and healthcare sites and, in turn, created proxies for employment and shopping/commerce. **Table 6.5** shows the destination types I selected and the iterations of those destinations in AGBA and the case study departments.

Table 6.5: Number of sites per destination category, in Agglomerated Buenos Aires (AGBA) and all three case study departments

Destination Type	Sub-Type	AGBA	Quilmes	La Matanza	Pilar	All 3 Cases
Central Business Districts	C.A. Buenos Aires	1				
	Department C.B.D.	30	1	1	1	**3**
	Proximate C.B.D.	21	6	8	9	**23**
Railroad Stations		240	19	42	23	**84**
Healthcare	Public Urgent Care	15	7	9	6	**22**
	Diagnostic/Treatment	1,076	70	81	51	**202**
	Hospitals	80	11	19	10	**40**
Public Schools	Kindergartens	1,602	120	148	66	**334**
	Primary Schools	1,973	109	203	77	**389**
	Secondary Schools	1,674	78	199	74	**351**

Source: Calculated by author

As the most common trip type in AGBA, I first sought major employment centers. Lamentably, the Argentine government does not publish geographic information on employment locations and, to make matters worse, the types of employment associated with *asentados* (e.g., carpenters, domestic workers, and street vendors) are not location-specific enough to permit estimations. I elected to use central business districts in their stead. While evidence shows that employment in AGBA is more dispersed than ever, CBD's still feature high relative employment densities. They also serve as centers of commerce and local government, making them reasonable proxies for some of the job and shopping trips made by *asentados*. While most *asentados* are unlikely to leave their neighborhood for daily shopping (e.g., groceries), Cravino, et al. (2008) found that a handful of people did leave their *asentamiento* to buy high-ordered, luxury items like hardware or home electronics, goods most likely purchased at retail outlets commonly found in central business districts in Buenos Aires. Obviously, these assumptions about CBD's do not account for all shopping or jobs. This is especially true as service sector outlets have dispersed throughout the conurbation's departments and industrial jobs have relocated from their traditional hearth inside of CABA to AGBA's outer highways.

In all, three CBD queries were performed for each radio: the first to Buenos Aires' central business district (in CABA), the second to the CBD of its respective department, and the third to the nearest CBD of any department in AGBA. This variation was done to capture the *asentados* working in the different parts of the metro area (according to Cravino, et al. 2008): 8.7% in the federal district, 17.7% in a separate department, and 48.1% in their home department. Including the neighboring departments (the third query) additionally accounted for *asentados* in the far periphery of their respective departments who likely live closer to a neighboring CBD (and its corresponding commercial/employment opportunities) than their own. Understanding the travel times to known employment centers can not only show whether *asentados* have a more difficult journey to work but also, should those times be significantly longer than those for people from formal neighborhoods, why so many of them (26% of respondents) need to work in or nearby their home neighborhood.

Data on central business districts was downloaded from the geographic data portal of the Ministry of the Interior, Public Works, and Housing.[9] More specifically, I used a layer called "Localities' head of local government" ("Localidades cabecera de gobierno

[9] http://sig.planificacion.gob.ar/layers/ultimas

local segun tipo de gobierno"), created during Argentina's 2010 national census.[10] The data were most recently updated on 19 January 2018. I uploaded the layer, a point shapefile, into ArcGIS where I used the program's database query tools to select the points individually pertaining to the three case studies: Quilmes, La Matanza, and Pilar. I then used the program's spatial query tools to select those departments that bordered each of these three: nine for Pilar, eight for La Matanza, and six for Quilmes. Once identified, I selected the CBD that corresponded to each of those neighbors. For each of my three case studies, I exported (1) a point file that included its own CBD and (2) a file for those identified as its neighbors'. Lastly, I exported these points as separate files. As for CABA's central business district, I created a custom point file with a single feature placed at the *Obelisco*, a major landmark along Buenos Aires' central 9 de Julio Avenue that is widely considered the city's center point. These points are mapped in **Figure 6.11**.

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[10] http://sig.planificacion.gob.ar/layers/detalle_capa/awagne_cabecera_gob_local/

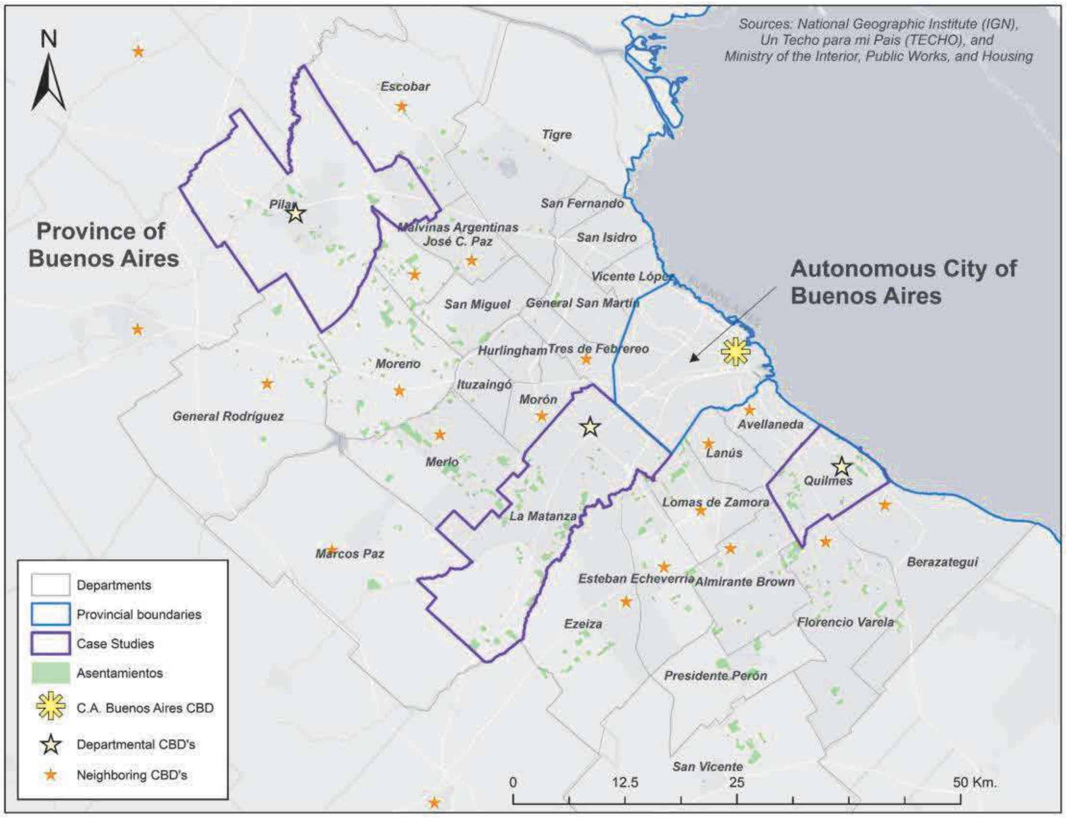


Figure 6.11: Central business districts of Agglomerated Buenos Aires (AGBA), featuring those included as "destinations" for the corresponding API requests

The second destination types were railroad stations. While railroad usage has declined for decades in metropolitan Buenos Aires, commuter trains still serve as the primary mode of travel for trips between CABA and the departments in the province and, as a mode, is frequented more by people in the lowest two income quintiles than those at the top (Secretaría de Transporte 2011). Furthermore, the areas around train stations, a legacy of Buenos Aires' early history, are some of the most densely populated spaces in AGBA outside of CABA. Consequently, they remain significant centers of employment, commerce, and residence (Blanco 2014). While Cravino et al. (2008) found that just 5% of surveyed *asentados* rode the train, this was mainly due to the study settlements being far from their nearest train stations. This characteristic, in fact, speaks to the importance of studying access to rail. Longer relative travel times will show the isolation of *asentamientos* relative to existing infrastructure and therefore depict how *asentados* are spatially disadvantaged in the job search, especially to the lower-skill positions commonly found in the urban core.

As with the central business districts, I acquired data on railroad stations from the data portal of the Ministry of the Interior, Public Works, and Housing. The specific layer was called "Railroad Stations" ("Estaciones de Ferrocarril") and was last updated on 28 December 2016.[11] I uploaded it to ArcGIS, finding 240 total stations. Since the goal of this API request, in contrast to the CBDs, was to identify the *nearest* stop to each origin point, the ideal situation would have been to calculate the travel time between each origin and each station, selecting only the minimum value. This, however, required a prohibitively large number of API requests, leading me to invent an ad-hoc technique to cut down on queries (a process I also employed for schools and hospitals).

I first assumed that most travelers would only use stations within a reasonably-short distance of their home. ENMODO, in fact, says that most trips (whether for work, school, and health) are within the same or adjoining departments (Secretaría de Transporte 2011). I thus used ArcMap's spatial proximity tools to determine which stations, of the 240, were one of the *ten closest* (per Euclidean distance) to each of the sampled census radios. I assumed it likely that *asentados* would only use one of the ten closest stations to their home (even if network distance, and not straight-line distance, actually informed this choice).

[11] http://sig.planificacion.gob.ar/layers/detalle_capa/mrapis_est_ferrocarril_final/

For each of the three study districts, I created a separate point file of just those train stations that qualified under this scheme; this reduced the number of destinations to just 19 for Quilmes, 23 for Pilar, and 42 for La Matanza. In each case, some of these stations (if not most of them) were geographically outside of the bounds of the home department. I collected the latitude and longitude coordinates of each station, formatted those coordinates for compatibility with the API engine ("LATITUDE+LONGITUDE"), and exported the values as a csv file whose data could easily be read into R. **Figure 6.12** is a map of the rail stations, highlighting those included as "destinations" for the API.

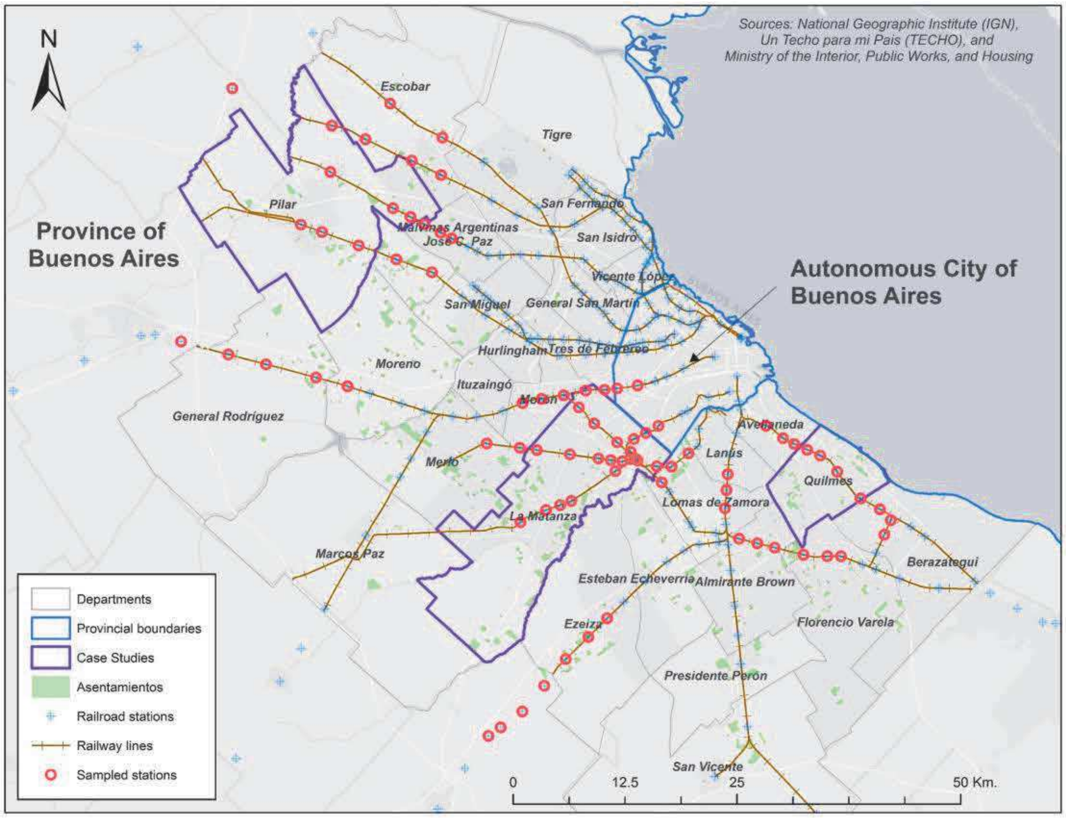


Figure 6.12: Railroad stations of Agglomerated Buenos Aires (AGBA), featuring those included as "destinations" for the corresponding API requests

While prior studies indicate that most *asentamientos* have schools nearby, I included them anyway. The data were easy to find, and student trips represent a large share of region-wide trips. The Province of Buenos Aires, within its open data portal, publishes a spreadsheet of all the schools in its territory.[12] Officially titled "Educative Establishments" (Establecimientos educativos), the layer contains the latitude/longitude coordinates of each school, its education level (e.g., primary, secondary, tertiary), and whether it is private or public.[13] Downloadable as a comma separated values (csv) file, these data's coordinates were easily displayed as point files within ArcMap. This file was last updated on 21 February 2018.

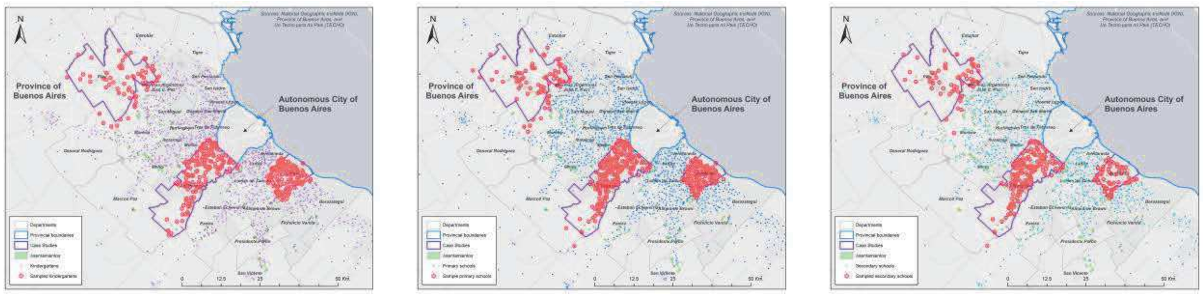
[12] http://catalogo.datos.gba.gob.ar/home

[13] http://catalogo.datos.gba.gob.ar/dataviews/245163/establecimientos-educativos/

With 22,290 schools, I had to narrow down the number of activity sites for the API. I first sub-selected the public schools (“estatales”). Aside from colloquial advice from Argentine contacts that *asentados* were more likely to attend to public schools (which are free), ENMODO shows that public schools to be favored by the population at large (71%) and also students from all five income quintiles. Furthermore, the lowest quintile (the most likely to contain *asentados*) had a remarkable 84% of its students as public-school attendees (Secretaría de Transporte 2011). This reduced the number of schools to 16,035.

To whittle the total further, I selected just three types of public schools: kindergartens (“jardin de niños”), primary schools (“primarios”), and secondary schools (“secondarios”). I based this decision on INHABITAT results showing that most *asentados* had little more than a primary education: 71.9% completed any primary and 23.3% for secondary. Less than 2% had made it beyond (Secretaría de Transporte 2011). While it is possible that tertiary- or university-level schooling was not pursued for reasons of access, the total number of potential students is certainly smaller than those at other lower levels. This reduced the schools to: 2,671 (kindergartens), 4,262 (primary), and 2,729 (secondary). I excluded public schools in CABA due to colloquial advice that students probably do not travel long distances to reach public schools. Each of the case study *asentamientos* are far from CABA, with dozens of interceding schools more likely to be used by their students.

Lastly, I selected, using the same Euclidean distance technique as before, only those schools that were one of the ten-closest to any one of my “origins”. I replicated this task for all three study areas. This produced nine files: the nearest schools in all three categories for all three districts. Like before, I took the initial step, before exportation, to tabulate the coordinates and re-format them for the API. **Figures 6.13a-c** show maps of the kindergartens (**6.13a**), primary schools (**6.13b**), and secondary schools (**6.13c**), highlighting those included as “destinations” for the API.



Figures 6.13a-c: Public kindergartens (left), primary schools (center), and secondary schools (right) of Agglomerated Buenos Aires (AGBA), featuring those included as “destinations” for the corresponding API requests

The last destination category was health care; unlike the other activity classes, these came from multiple sources. I first intended to use the “public healthcare establishments” (“establecimientos de salud públicos”)[14] and “private healthcare establishments” (“establecimientos de salud privados”) spreadsheets published in the data portal from the Province of Buenos Aires. However, neither differentiated subcategories, making it impossible to know the facilities’ sizes or scopes: small clinics are included together with hospitals and other specialist facilities. The only exceptions are “urgent care units” (“unidades de pronta atención” or “prompt attention units”), fifteen of which were included in the public establishments sheet. According to local news sources, UPA’s (an acronym I adopted) are meant to assist cash-strapped hospitals in the provision of first-aid services to members of the community.[15] I included them as logical

[14] http://catalogo.datos.gba.gob.ar/dataviews/245383/establecimientos-de-salud-publicos/
[15] http://www.po.org.ar/prensaObrera/online/politicas/buenos-aires-desmantelamiento-de-las-unidades-de-pronta-atencion-y-crisis-sanitaria

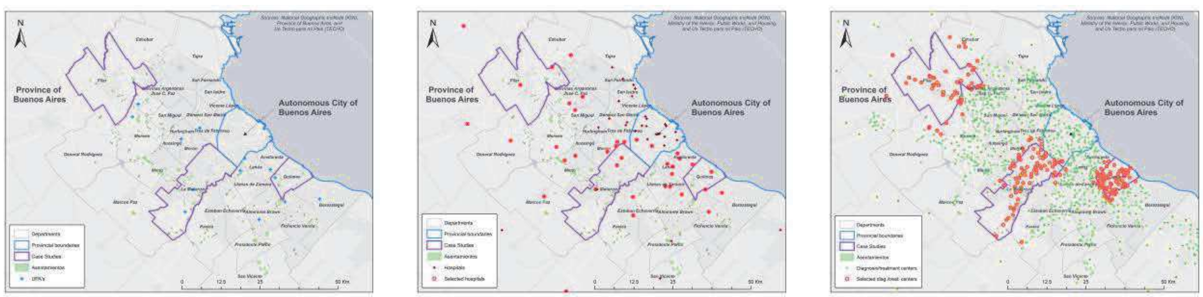
destinations for low-income *asentados.* I do not, however, have evidence of actual *asentados* using the UPA's, or any other specific type of health facility.

Looking to add traditional hospitals and health clinics, I returned to the GIS portal from the Ministry of the Interior, Public Works, and Housing. Here, I found two layers: "centers with general hospitalization" ("centros de internecion general")[16] and "centers of diagnosis and treatment without hospitalization" ("centros de diagnóstico y tratamiento sin internación").[17] Both derived from data from the Ministry of Health, and both were last updated in May 2017. These are point shapefiles with the address, coordinates, the name, and the governmental level (federal, municipal, or national) responsible for each facility. Separating out the hospitals from the diagnostic/treatment centers (a full definition of which was not provided) was important to distinguish between their levels of service and, therefore, their corresponding variation in population thresholds. I assume that hospitals, which allow patients to stay overnight, offer a greater array of services than a diagnostic/treatment center, which does not house patients. In turn, the former likely draws people from further distances than the latter. I selected public establishments under the assumption that low-income *asentados* were more likely to seek services where they are free; this opinion was informed by a conversation with professor Jorge Blanco, the chair of the geography department at the University of Buenos Aires.

Given that all three datasets, in their raw form, represented large scales (the whole province for the UPA's and the entire country for the latter two), I had to narrow the pool of destinations ahead of my API requests. For the UPA's, I first sub-selected them from the provincial dataset of public health establishments (2,586 units); only 19 were found in

[16] http://sig.planificacion.gob.ar/layers/detalle_capa/daniela_centros_con_internacion_gral/
[17] http://sig.planificacion.gob.ar/layers/detalle_capa/daniela_centros_diag_y_tratam_sin_internacion/

the Greater Buenos Aires region. With this step complete, I then added the nationwide point-shapefiles for hospitals (1,114) and diagnostic/treatment centers (7,985). Next, I used my Euclidean distance technique to select the individual establishments that were one of the ten closest sites to a study radio. Performed for each healthcare destination and for each department, I created nine point-files, to which I added the necessary latitude/longitude information. **Figures 6.14a-c** show maps of the UPA's (**6.14a**), hospitals (**6.14b**), and diagnostic/treatment centers (**6.14c**), highlighting those included as "destinations" for the API.



Figures 6.14a-c: UPA's (left), public hospitals (center), and public diagonstic/treatment centers (right) of Agglomerated Buenos Aires (AGBA), featuring those included as "destinations" for the corresponding API requests

Section 6d: API Parameters for Mode, Time, and Day

After acquiring the latitude and longitude coordinates of my origins and destinations, I set the remaining travel-time request parameters: mode of travel, departure time, and departure day.

Given this thesis' topic, the mode was set to "transit," the API's generic setting for computing travel time using all public transportation modes available in an area: bus, rail, and subway. Considering bus (39%) and rail (5%) together, public transit was easily the most common mode preferred in INHABITAT's survey. With no obvious reason to prioritize any one mode over the others, I included them all. This choice is supplemented by ENMODO's findings that public transit was favored by workers (57% against 27% for private and 16% for non-motorized) and represented the choice of more than 60% of domestic workers, industrial workers, and company employees. Income-wise, those from the lowest quintile were also less likely to take private transit to school and more likely to walk or take the bus on health-trips. Students, meanwhile, were also more likely to travel on public transit (Secretaría de Transporte 2011).

While it would be interesting to eventually compare travel times between the rival modes offered by the API (driving, walking, or biking), there are arguments for their exclusion. For instance, driving is irrelevant to *asentados* given its price exclusivity (less than 2% of INHABITAT respondents used a car for travel). Knowing the driving times to activity sites from the *asentamientos* might be interesting from a comparative perspective (showcasing the growing transit/driving dichotomy in Buenos Aires). Nonetheless, auto travel is simply not a feasible choice for typical *asentados*. Walking and biking, meanwhile, are necessitated by the absence of reasonable transit or outright poverty. In fact, more than 50% of non-motorized trips to school are done by those in the first income quintile. Nonetheless, walking is not likely a viable option for the trip-types studied by this thesis. Higher-order destinations like CBDs and hospitals are simply too far away for travel on foot. *Asentados* are more likely to not travel than walk or bike to jobs in far-off locations. Additionally, knowing the walking or driving times to activity sites is not of much use without first knowing the quality of transit, which could then contextualize any long walking or biking trips *asentados* are forced to make (Secretaría de Transporte 2011).

As for departure date, the second remaining parameter, I sought to capture the transit services available to the citizens of AMBA on an average work or school day. In turn, I selected Wednesdays to serve as my generic weekday. Based on personal experience in Argentina, Wednesdays are not likely to overlap with public holidays, which often take place on the days immediately preceding or following the weekend and feature special transit schedules akin to those on a typical weekend day. Justification of a general weekday falls in line with ENMODO statistics showing that 74% of all trips, regardless of type, are made five-times a week. This suggests that trips on Wednesday are probably similar to those made on the other four days.

When it came to the final parameter, travel time, I opted for a more nuanced approach. Using the time-of-travel information from the ENMODO survey, I gleaned the peak hour of different trip types: 7:00am for work trips (9-10% of all work trips—the highest evening peak was 9% at 5pm and 8.5% at 6pm), 10:30am for health-related travel (peaks at 10am and 11am, with smaller peaks around noon, 9am, and 3-4pm), and 12:00pm for school trips (there were other peaks at 7am and 5pm—corresponding to the start of morning session and culmination of the afternoon session) (Secretaría de Transporte 2011). The noontime peak consists of students returning home after class, going to school before class, and returning home for lunch before returning for the afternoon session. Likewise, it is also the peak travel time for students attending all three types of schools under study: kindergarten, primary, and secondary. There is no clear way, however, to determine what percentage of these trips are going in either direction it could be that most of the home-to-school trips are also at 7am. Nevertheless, I also chose noon simply to capture accessibility trends during a different time of day than the work-trips, already set to the early morning hours.

Once all the parameters were set (API keys, origins, destinations, modes, day-of-week, and times-of-departure), I made my requests. I requested data over the course of five weeks between February and March 2018. In cases where the number of origins or destinations exceeded the API's limit of 25 entries, I sub-divided the latitude and longitude sites into groups of twenty-five and fed them into the API separately. The total number of requests is summarized in **Table 6.6**.

Table 6.6: Summary of all Google Maps Distance Matrix API requests performed between February and March 2018

Departments of Origin	Number of Origins	Google Maps Distance Matrix API requests, by destination type									
		Buenos Aires CBD	Departmental CBD	Train Station	Nearest Dept. CBD	Public Urgent Care Center	Public Hospital	Pub. Diagnostic/Treatment	Public Kindergarten	Public Primary School	Public Secondary School
Pilar	72	72	72	1,656	648	432	720	3,672	4,752	5,544	5,328
Quilmes	92	92	92	1,748	552	644	1,012	6,440	11,040	10,028	7,176
La Matanza	120	120	120	5,040	960	1,080	2,280	9,720	17,760	24,360	23,880
Travel Mode		"Transit"									
Departure Time		7:00 AM				10:30 AM			12:00 PM		
Departure Day		"Wednesday"									

Post-processing was simple, although a few extra steps were required for destination types with multiple sites. The output, for each request, was a matrix of origins and destinations, with time values in seconds. The unique identifier for the origins (rows) and destinations (columns) was the "LATITUDE+LONGITUDE" script that was fed into the API. For the two cases where there was only one destination—Buenos Aires' CBD and the local departmental CBD—I only had to convert the times from seconds to minutes. For the remaining tables, I had to perform an extra function—using a tool within

R—to select the *minimum* time in all the columns for each row. This script, in turn, produced a new matrix with just two columns: the unique identifier for a given origin and the travel time to the closest iteration of that activity class. Lastly, I converted this value to minutes. With the original shapefiles and these time matrices sharing a common attribute (the latitude and longitude in "LATITUDE+LONGITUDE" format), I joined the R-output times tables to the census radio shapefiles in ArcGIS to map my results.

Section 6e: Difference-of-Means Tests, ANOVA and T-Tests

Given that the primary question underlying this project is whether the *asentamientos* enjoy better or worse transit-facilitated accessibility than the rest of metropolitan Buenos Aires, I opted for statistical procedures that test differences of means. More specifically, I needed to compare the average travel times between: (1) those census radios designated as majority-overlap, minority-overlap, and no-overlap, as well as, (2) between those designated any-overlap and those with no-overlap. The former, given its three-sample comparison, warranted an ANOVA (analysis of variance) test, while the latter required a series of independent-sample t-tests.

ANOVA, or analysis of variance, tests compare the means of three or more samples of ratio or interval data to see if they are statistically independent. Simultaneously looking at differences in variation within and across the study samples, ANOVA can test both the variation of each sample around the "total mean" of all samples and the variance within each of these samples around their respective means. As stated by McGrew et al. (2014), "if the variability between the group means is relatively large as contrasted with the relatively small amount of variability within each group around its group mean, then the statistical conclusion is likely that the different groups have been drawn from different populations" (p. 175). In other words, if the means of the independent samples are sufficiently different from one another, they are probably from different populations and, therefore, statistically-significantly different.

The test statistic for an ANOVA test is the F-statistic and is derived from the relative difference in variances between and within the different samples. High F-scores indicate that the between-group variance is much larger than the within-group variances (the former is divided by the latter to get the F-score), and it is unlikely that all the samples were drawn from the same population and that *at least one* of those samples is from a separate population. This would reject the null hypothesis for an ANOVA test that all samples are from the *same* population, and that their means and variances are all equal. The higher an F-score, the more likely the null hypothesis is not true. Nevertheless, such a conclusion can only be met if the ANOVA's main assumptions are met: (1) that there are three or more independent random samples, (2) that each population is normally distributed, (3) that each population have equal variance, and (4) that the variables are measured on an interval or ratio scale.

In my case, I am comparing travel times between the three samples of census radios, grouped by their overlap with AGBA's *asentamientos*: majority-overlap, minority-overlap, and no-overlap. Performed on the travel time estimates for all ten activity sites, the goal is to see whether the mean times of the majority- or minority-overlap radios are statistically-significantly different from those qualified as no-overlap. An ANOVA test on these samples will determine if the travel times for the majority- or minority-overlap groups are from a different population of travel times than those in the control group. What the test will not do, however, is indicate which specific samples are different from one another; if the F-statistic is high, this could be because all three samples are different from one another or that just one of them is different.

Given that it does not specify which, or how many, of the sample means are different from the others, I added robustness to the ANOVA test with a series of independent-sample T-tests. Similar in nature to the ANOVA, these are used to compare the means and variances of just *two* independent samples. Requiring that the two samples be independent and random, normally distributed, and measured on an interval or ratio scale, a significant t-test rejects the null hypothesis that the two samples' means are equal (and, therefore, from the same population). The higher the t-score, the lower the likelihood that the two samples are from the same population. A caveat of the t-test comes from whether the population variances for the two samples are known. If they are not, which is the case for this thesis, then the sample mean is forced to stand in for the population mean. If the sample is small (i.e., less than 30 cases), it is probable that the sample mean is not a good representation of the population mean and that a t-distribution should be referenced. If the sample is greater than thirty, the sample mean is likely more representative of its' population-level equivalent and a z-distribution can be assumed.

In this study, there are several plausible t-tests, each characterizing the ANOVA results. I examine the differences-in-means between: (a) majority- and minority-overlap radios, (b) any-overlap and no-overlap, (c) minority- and no-overlap, and (d) majority- and (e) non-majority-overlap (minority + none). I performed a t-test on the travel times in each district, and to each destination, and see if the corresponding radios display significant differences. A significant ANOVA test, say for the "distance to Buenos Aires CBD" measure, alongside significant t-tests for all the paired combinations of overlap-categorizations (and especially for the majority-none and minority-none tests) would provide strong evidence that the *asentamientos* enjoy worse transit-based accessibility than their neighbors. Contrary results, perhaps a significant F-statistic with insignificant t-tests, would help clarify, if not nullify, the initially expected conclusion.

The results of these tests are given in the next chapter.

Chapter 7: Results and Discussion

Section 7a: All Case Studies

The average, standard deviation, minimum, and maximum travel time values, from the census radios across all three study areas, are shown in **Table 7.1**. The range of values for each destination activity type are shown on the box plots in **Figure 7.1**. Lastly, the average times for each of the five overlap categories—vis-à-vis destination activity types—are shown on the line graph in **Figure 7.3. Appendix A** contains maps of the travel times, to all destination types, from the sample census radios across AGBA.

Table 7.1: Descriptive statistics for travel times on public transportation, from all sampled census radios to all destination types

Sample	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
All (284)	Average	114.1	64.7	59.8	34.5	63.5	44.7	14.7	11.7	10.0	10.8
	St. Dev.	40.5	39.6	38.2	24.5	34.3	27.6	10.4	9.0	8.7	8.4
	Minimum	41.9	2.2	2.2	2.6	9.2	1.5	0.2	0.1	0.1	0.1
	Maximum	274.6	232.6	232.6	182.6	188.5	195.9	72.5	54.9	50.6	57.5
Majority (52)	Average	123.3	80.7	76.7	42.3	57.0	54.2	14.4	9.5	9.3	11.2
	St. Dev.	37.1	40.3	39.3	28.3	26.4	30.0	8.6	6.5	7.0	7.4
	Minimum	66.6	12.7	12.7	12.7	17.7	11.2	4.1	2.2	2.2	2.8
	Maximum	274.6	232.6	232.6	182.6	129.6	195.9	39.0	40.2	42.5	42.4
Minority (90)	Average	122.9	72.2	67.1	40.0	64.9	52.1	16.1	13.9	12.3	12.3
	St. Dev.	43.3	38.2	38.1	24.0	40.5	26.2	10.9	8.7	9.2	7.7
	Minimum	56.6	8.2	8.2	11.3	11.0	8.8	0.2	1.5	1.6	0.9
	Maximum	240.6	198.8	198.8	133.9	188.5	157.9	43.1	42.3	49.1	41.3
Any Overlap (142)	Average	123.1	75.4	70.6	40.8	61.9	52.8	15.5	11.3	12.9	11.2
	St. Dev.	41.0	39.0	38.7	25.6	36.0	27.6	10.1	7.4	8.3	8.6
	Minimum	56.6	8.2	8.2	11.3	11.0	8.76	0.2	0.9	1.5	1.6
	Maximum	274.6	232.6	232.6	182.6	188.5	195.9	43.1	41.3	42.4	49.1
No Overlap (142)	Average	105.2	54.3	49.0	28.2	65.0	36.7	13.8	10.3	10.6	8.8
	St. Dev.	38.2	37.5	34.5	21.6	32.6	25.3	10.7	9.2	9.6	8.7
	Minimum	41.9	2.2	2.2	2.6	9.2	1.5	1.2	0.1	0.1	0.1
	Maximum	238.7	193.7	193.7	128.7	187.7	155.4	72.5	57.5	54.9	50.6

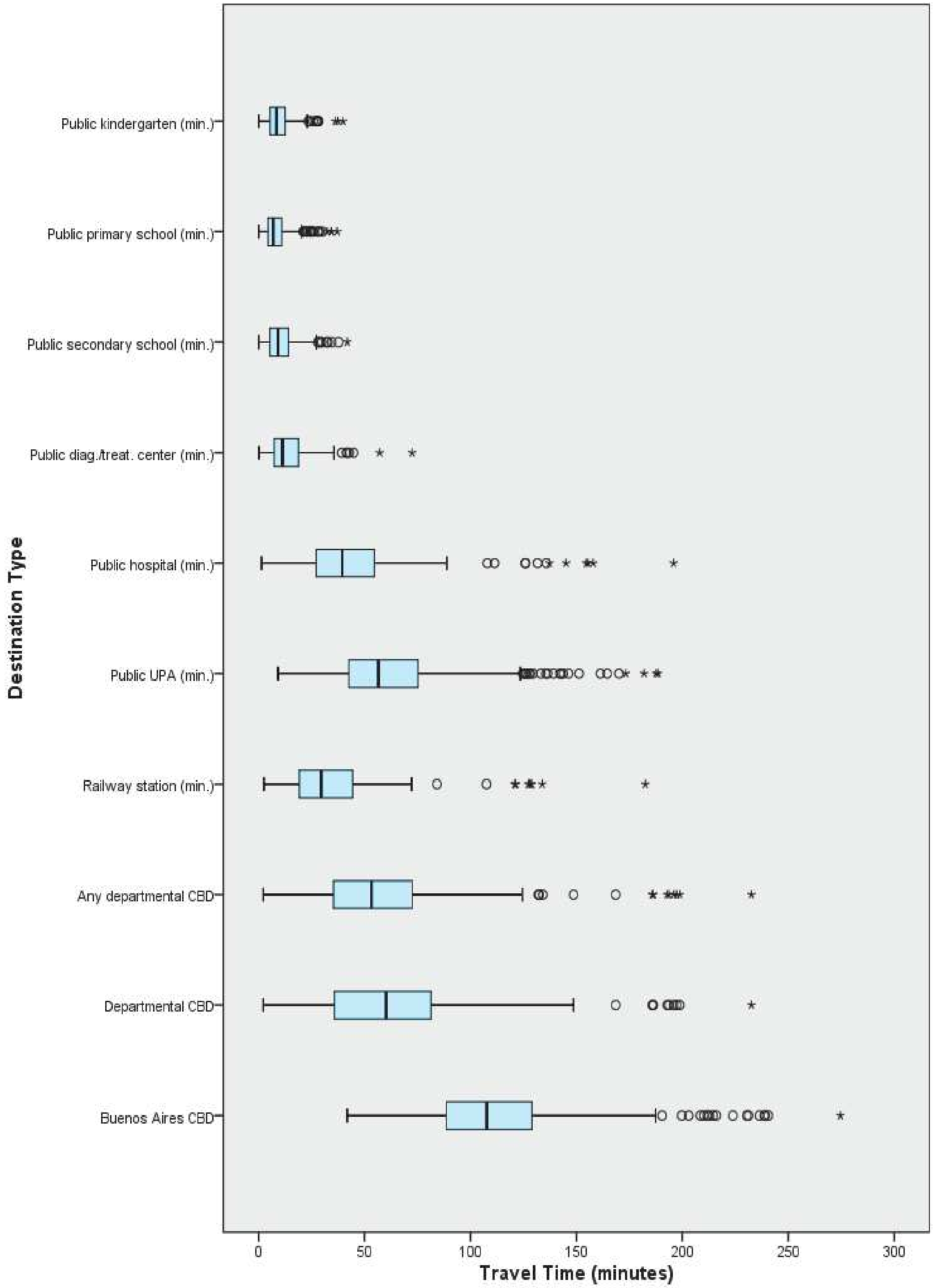


Figure 7.1: Box plots showing the distribution of travel times on public transportation, from all sampled census radios to all destination types

The range of expected travel time values is substantially different for the different destination activity types. As shown on **Figure 7.1**, nearly all the schools, as well as the diagnostic/treatment centers, were within an hour's minimum travel of a census radio, regardless of its location in the conurbation. Conversely, the variation in travel time values to the central business districts is enormous, with values as low as half-an-hour to some as high as four hours. Each distribution presents a right-ward skew, with abundant outliers, suggesting that there are some radios with unusually long travel times to destinations. Even lower-order activity type, like schools, show outliers. These skewed distributions, meanwhile, are to be expected given the impossibility of extreme negative outliers (i.e., negative values) with time-based values.

All the while, the initial travel time findings (**Table 7.1**) are hardly a surprise. Those activity types with more locations, like schools, inherently require less travel than those with fewer, like the central business districts, hospitals, and railway stations. One other thing to keep in mind when inspecting these data is that they include values from across the region, so values from La Matanza and Pilar (which are both farther, on average, from CABA than Quilmes) skew the distribution to the right.

One of the weaknesses of this study, and all Google Distance Matrix API data in Buenos Aires, is the difficulty in verifying these travel times. There is no way, without real time monitoring of people's on-the-ground movements, to determine if these estimates are accurate. Furthermore, none of the prior studies of accessibility in the *asentamientos* captured data on time for comparison. Perhaps the only comparison point are those trip times reported to ENMODO. **Table 7.2** shows the travel times recorded by respondents based on trip type and mode choice. School trips most commonly took only 10 to 20 minutes, whereas work trips and health trips frequently required more than a half-an-hour. My results present a similar pattern, with schools requiring less time relative to those for employment/commercial sites or healthcare. The relative similarity of the API's outputs to these self-reported travel times adds credence to this thesis' findings.

Table 7.2: Distribution of travel times recorded by 2009-10 ENMODO origin/destination survey, categorized by mode and trip-type

	Trip Mode			Trip Types				
Travel Time	Public Transit	Bus	Rail	Workers	Study	School, Primary	School, Secondary	Health
< 10 minutes	2%	2%	1%	17%	26%	36%	27%	8%
11-20 minutes	11%	12%	3%	20%	29%	37%	30%	20%
21-30 minutes	17%	19%	7%	18%	19%	16%	21%	25%
31-60 minutes	34%	35%	30%	27%	18%	9%	18%	31%
60 > minutes	36%	32%	59%	18%	8%	<5%	5%	16%

Source: Secretaría de Transporte (2011)

The data across all three study areas only demonstrate general differences between trip types. Sub-dividing the travel times based on whether they originated from *asentamientos* begins to answer more pertinent questions of differential access. **Figure 7.2** graphically depicts the variation in average expected travel times, to each destination type, for radios with majority-, minority-, any-, and no-overlap.

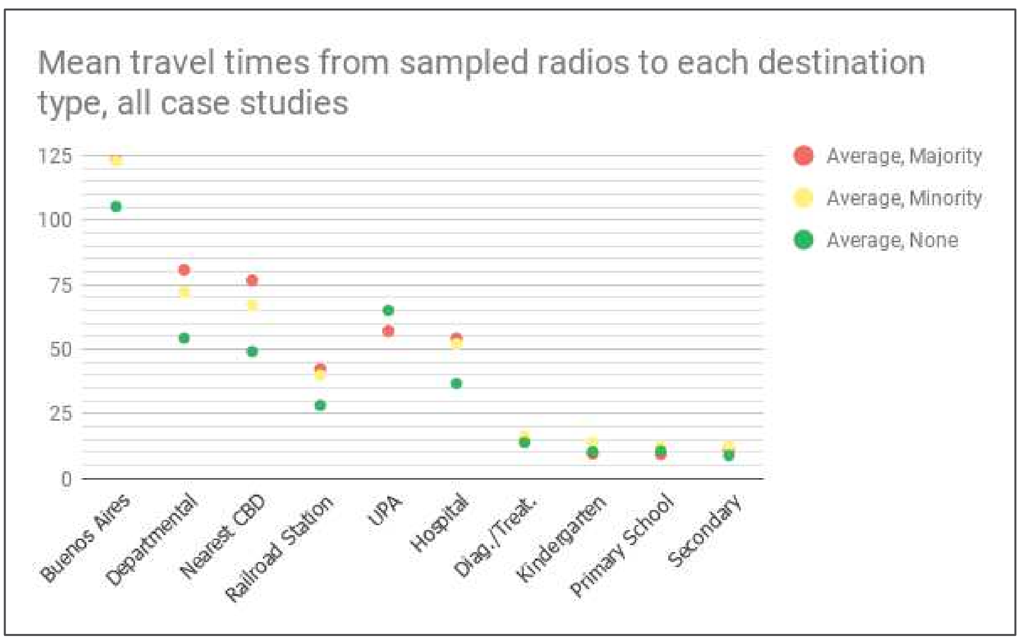


Figure 7.2: Graph of the average expected travel times to all destination types, from all sampled census radios, ordered by degree of overlap with an *asentamiento*

The travel times associated with the majority- and minority-overlap radios are substantially higher than those with no-overlap for five of the first six destination categories: the three CBD's, railway stations, and hospitals (all higher-order). As for the local CBD's, the gaps are wide, with thirty minutes separating the two groups. The gap is less pronounced for the Buenos Aires CBD, railway station, and hospital measures. Conversely, there is almost no gap for the schools or diagnostic/treatment centers, although this is likely due to the minimal absolute variance in their travel time distributions. The urgent care units (UPA's) provide an unexpected result: the no-overlap radios feature *worse* travel times than those radios with any-overlap, a promising result given that UPA's were purposively constructed in underserved areas.

These patterns are clear on the maps showing travel times across all three cases (**Figures A.1-10**). Separate colors are used to depict census radios by their degree of overlap with an *asentamiento* (red for majority, yellow for minority, and green for none), with the travel times from those radios illustrated by circles of varying size (larger circles for longer times and vis-versa for shorter trips). Notice how the smaller circles predominate all three study areas for the schools and diagnostic/treatment centers (**A.7-10**) while times were much more variant across the other destination types (**A.1-6**). The highest absolute values, across all case studies, were in Pilar and La Matanza (especially the southern half of the latter department). Quilmes' radios, meanwhile, had relatively short travel times compared to the other two; even its highest values were travel times much shorter than those seen in the worst parts of La Matanza and Pilar.

The results of the ANOVA and t-tests performed on the travel times pertaining to all the sampled census radios, from all three case studies, are in **Table 7.3**.

Table 7.3: Results of ANOVA and independent-sample t-tests, travel times from the sampled census radios from all three case studies, delineated by degree of overlap with an *asentamiento*, to all destination types

Samples of Comparison	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
ANOVA											
Majority, Minority, None	F-statistic	6.83	11.16	12.94	9.76	1.10	12.84	1.39	2.38	4.92	3.89
	p(F)	0.00	0.00	0.00	0.00	0.33	0.00	0.25	0.10	0.01	0.02
T-Tests											
Any vs. None	t-statistic	3.70	4.55	4.86	4.39	-0.73	5.06	1.34	2.17	2.38	0.99
	p(t)	0.00	0.00	0.00	0.00	0.47	0.00	0.18	0.03	0.02	0.32
	Mean diff.	17.84	21.12	21.60	12.60	-3.06	16.21	1.66	2.31	2.43	0.98
	St. Err. (diff.)	4.82	4.64	4.45	2.87	4.18	3.21	1.24	1.06	1.02	0.99
Majority vs. Minority/ None	t-statistic	1.79	3.21	3.54	2.52	-1.49	2.72	-0.24	-0.50	-0.76	-1.23
	p(t)	0.07	0.00	0.00	0.01	0.14	0.01	0.81	0.62	0.45	0.22
	Mean diff.	11.34	19.57	20.72	9.54	-7.98	11.61	-0.38	-0.69	-0.86	-1.58
	St. Err. (diff.)	6.32	6.10	5.85	3.79	5.36	4.27	1.60	1.39	1.13	1.28
Majority vs. Minority	t-statistic	0.06	1.22	1.39	0.52	-1.37	0.42	-1.08	-1.88	-2.21	-2.32
	p(t)	0.96	0.22	0.17	0.61	0.17	0.67	0.28	0.06	0.03	0.02
	Mean diff.	0.40	8.48	9.57	2.35	-7.91	2.09	-1.79	-2.71	-3.02	-2.81
	St. Err. (diff.)	7.35	6.95	6.87	4.56	5.79	4.93	1.65	1.44	1.37	1.22
Minority vs. None	t-statistic	3.17	3.45	3.64	3.78	-0.02	4.36	1.59	2.65	2.96	1.72
	p(t)	0.00	0.00	0.00	0.00	0.98	0.00	0.11	0.01	0.00	0.09
	Mean diff.	17.69	17.98	18.06	11.74	-0.10	15.44	2.31	3.30	3.54	2.01
	St. Err. (diff.)	5.58	5.21	4.96	3.11	4.97	3.54	1.45	1.25	1.20	1.17
Majority vs. None	t-statistic	2.89	4.19	4.66	3.61	-1.56	3.99	0.32	0.40	0.39	-0.58
	p(t)	0.00	0.00	0.00	0.00	0.12	0.00	0.75	0.69	0.70	0.57
	Mean diff.	18.09	26.46	27.63	14.09	-8.02	17.52	0.53	0.59	0.52	-0.80
	St. Err. (diff.)	6.27	6.32	5.93	3.90	5.14	4.40	1.65	1.47	1.34	1.39

99% confidence = , 95% significance = , 90% significance =

As indicated by the darkest green shading, the ANOVA tests for six of the destinations were significant at a 99% confidence level (all the central business districts, railway stations, hospitals, and, curiously, primary schools), one at 95% (kindergartens and secondary schools), and another at 90% (kindergartens). There is a statistically-significant difference in the average travel times between those census radios showing majority-overlap, minority-overlap, and no-overlap. We can reject the null hypotheses that those samples are drawn from the same population. Nevertheless, as noted before, this does not immediately prove my overarching hypothesis about relative accessibility in the *asentamientos*; these differences between each of these overlap-categories need to be considered individually, using t-tests, to see exactly where these differences lie.

Looking first at the six destinations whose ANOVA tests were highly-significant, their t-tests returned remarkably similar results. For the central business districts, railway stations, and hospitals, the greatest differences were between those radios with any degree of overlap (majority and minority) and those without. The t-tests were very highly significant (+99% confidence) for those comparing majority-overlap to no-overlap, minority-overlap to no-overlap, and any-overlap to no-overlap. These provide stronger evidence that the *asentamientos* enjoy worse access to these activity sites relative to their neighbors. As for the local CBD's, the t-tests comparing the majority-overlap radios with all others were also very significant, suggesting, in these cases, that those radios most likely representing *asentados* are those with the longest travel times.

The schools present different, yet interesting, results. While they each returned ANOVA tests of differing levels of significance, the differences-in-means seem to lie between different overlap-categories than the five discussed above. For the kindergartens and primary schools, the greatest differences, per the t-test results, are between the minority- and no-overlap radios (both 99%+ significance) with less of a difference between the majority- and minority-overlap samples and those for any- and no-overlap

(~95% significance). This suggests that there is some difference in estimated travel time between the *asentamientos* and their neighbors and they are greatest in those radios likely to fully represent *asentados*. The secondary schools, meanwhile, display only a highly significant difference (95% confidence) between the majority- and minority-overlap radios (the significance for this test was equal to that for the ANOVA for the same activity sites). These results, while interesting, do not lend as strong support for the overarching project hypothesis.

All the while, the access inequalities for schools illustrate the importance of measuring access in a *relative* manner. Even though there are hundreds of schools scattered across AGBA, with average travel times around fifteen minutes for each sub-category, there are still students spending significantly more time getting to school than their classmates. Even if the absolute differences are not as great for students as for other trip-makers, significant differences exist nonetheless (some are over 45 minutes) a burden on those few students who must take extra steps or acquire the fare to account for an earlier departure in the morning or late arrival home in the evening.

The last two activity destination types, the urgent care centers and diagnostic/treatment centers, returned insignificant results for all tests. With all census radios enjoying a similar degree of time-measured access, this suggests an equitable distribution of these opportunities. This is especially interesting for the UPA's of which there are just over a dozen across the entirety of AGBA. Perhaps this reflects good locational planning by public officials.

Some of these patterns are visible on the maps in **Figures A.1-10**. For instance, some of the largest circles, representing travel time, are colored red (majority-overlap) in several of the maps: Buenos Aires CBD (**A.1**), departmental CBD (**A.2**), any departmental CBD (**A.3**), and hospitals (**A.6**). Meanwhile, green circles (no-overlap) sport longer travel in others, noticeably UPA's (**A.5**) and the schools (**A.8-10**). Curiously, the largest circles pertaining to each of the individual case study departments, regardless of destination type, are not the same color (green for Pilar, red for La Matanza/Quilmes).

While most of these initial findings provide support to the argument that there is an inequality in public transport-supported access in the neighborhoods of metropolitan Buenos Aires, additional results can further any additional inequities. Unique geographies and urban landscapes are found in each of the three individual case studies: Quilmes, La Matanza, and Pilar. As such, it is important to know whether inequitable accessibility is a problem for all three cases or, if not, how it differs between them. The absolute travel time estimations for each study area are quite different from one another, possibly reflective of their particular urban environments. While Quilmes, for instance, has the shortest travel times to all destination types, this does not immediately implicate equitable accessibility. Consideration must be given to the territory of each case.

In the subsequent sections, I explore the results for Quilmes, La Matanza, and Pilar. For reference, Quilmes represents the fully-urbanized departments within traditional "greater Buenos Aires" (GABA), La Matanza for the partially-urbanized departments in GABA, and Pilar for those departments not historically considered part of the conurbation but that are being progressively urbanized and enveloped into the agglomeration at large. As will be seen, these characteristics are strongly reflected in each department's corresponding travel time patterns.

Section 7b: Quilmes

Table 7.4 contains descriptive statistics for the travel times tabulated for Quilmes' sample of ninety-two census radios.

Table 7.4: Descriptive statistics for travel times on public transportation, from all sampled census radios in Quilmes to all destination types

Sample	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
All (92)	Average	**81.2**	**49.0**	**43.3**	**34.0**	**46.3**	**33.4**	**8.6**	**8.1**	**6.9**	**10.8**
	St. Dev.	18.1	22.2	19.1	15.6	19.4	13.6	4.9	3.9	3.4	5.1
	Minimum	41.9	7.6	7.6	2.6	11.0	7.0	0.2	1.9	0.1	1.7
	Maximum	118.7	95.1	81.0	69.7	100.7	65.0	30.9	24.1	19.6	28.3
Majority (16)	Average	**90.4**	**53.2**	**50.2**	**41.9**	**51.5**	**37.5**	**8.8**	**8.6**	**8.0**	**12.5**
	St. Dev.	15.3	23.2	21.7	14.8	22.5	15.5	2.7	4.5	4.0	5.7
	Minimum	66.6	12.7	12.7	17.5	17.8	11.2	4.4	2.2	2.2	4.4
	Maximum	108.7	81.0	81.0	69.7	82.0	65.0	14.7	16.5	16.0	22.1
Minority (30)	Average	**85.0**	**56.0**	**48.7**	**37.6**	**41.0**	**37.1**	**8.0**	**8.2**	**7.3**	**11.9**
	St. Dev.	16.0	20.1	16.7	12.8	22.2	12.5	6.0	3.4	3.1	5.3
	Minimum	56.6	8.2	8.2	11.8	11.0	8.8	0.2	1.9	1.7	1.7
	Maximum	118.7	82.6	73.3	58.7	100.7	53.7	30.9	16.0	15.3	25.0
Any Overlap (46)	Average	**86.9**	**55.0**	**49.2**	**39.1**	**44.7**	**37.3**	**8.3**	**8.3**	**7.5**	**12.1**
	St. Dev.	15.8	21.0	18.4	13.5	22.7	13.5	5.1	3.7	3.4	5.4
	Minimum	56.6	8.2	8.2	11.8	11.0	8.8	0.2	1.8	1.7	1.7
	Maximum	118.7	82.6	81.0	69.7	100.7	65.0	30.9	16.5	16.0	25.0
No Overlap (46)	Average	**75.5**	**42.9**	**37.4**	**28.8**	**47.9**	**29.6**	**9.0**	**7.9**	**6.3**	**9.6**
	St. Dev.	18.7	21.9	18.1	16.0	15.6	12.8	4.6	4.1	3.4	4.6
	Minimum	41.9	7.6	7.6	2.6	11.2	7.0	2.7	1.9	0.1	3.2
	Maximum	109.0	95.1	77.0	67.9	77.5	58.8	24.1	24.1	19.6	28.3

Figure 7.3 shows box-plots representing the distribution of transit-based travel times to each destination type in Quilmes. I initially observed that the ranges for each attraction are considerably smaller than those for all three case studies (**Figure 7.1**) with less absolute variance. This is illustrated by the small number of outliers; some of the destinations have none at all. Schools and diagnostic/treatment centers against had the

shortest travel times whereas longer travel times are required, as expected, for the central business districts, railway stations, urgent care centers/UPAs, and hospitals (all of which require 45 minutes, on average). Unlike what we will see for the other two case studies, there are no trips longer than two hours (also visible on the travel time maps for Quilmes' census radios, **Figures B.1-10**). For trips with destinations in or near Quilmes' boundaries, the upper limit is only 90 minutes.

The history of Quilmes, a representative of other fully-urbanized departments in AGBA, explains these tendencies. According to Keeling (1996), Quilmes was first settled as a suburb of Buenos Aires during the 1950s; people working in the factories on the southern side of CABA lived in its neighborhoods and commuted to their jobs using the commuter railway line that connects CABA with Quilmes and the other departments on the city's southeastern flank. Rapid urbanization took place during the 1960s and 1970s, with increasingly more working- and lower-class people settling in its confines. Consequently, Quilmes is one of the poorest departments in the city, a haven for working-class *porteños*, and, once the *asentamiento* first began to appear, "a favored location for self-help settlements due to its proximity to the Federal District and to industrial plants" (Keeling 1996, p. 56).

Providing services to traditional neighborhoods, let alone informal settlements, has been a struggle for the cash-strapped municipality, whose population jumped from 300,000 in 1970 to 500,000 in 1991 and then nearly 600,000 in 2010 (Keeling 1996; INDEC 2010). Its small size, relative to departments on Buenos Aires' periphery, means that travel times within the district are inherently shorter than larger districts like La

Matanza. Nevertheless, its location and working-class legacy gives it an unusually large share of *asentados* for such a small department.

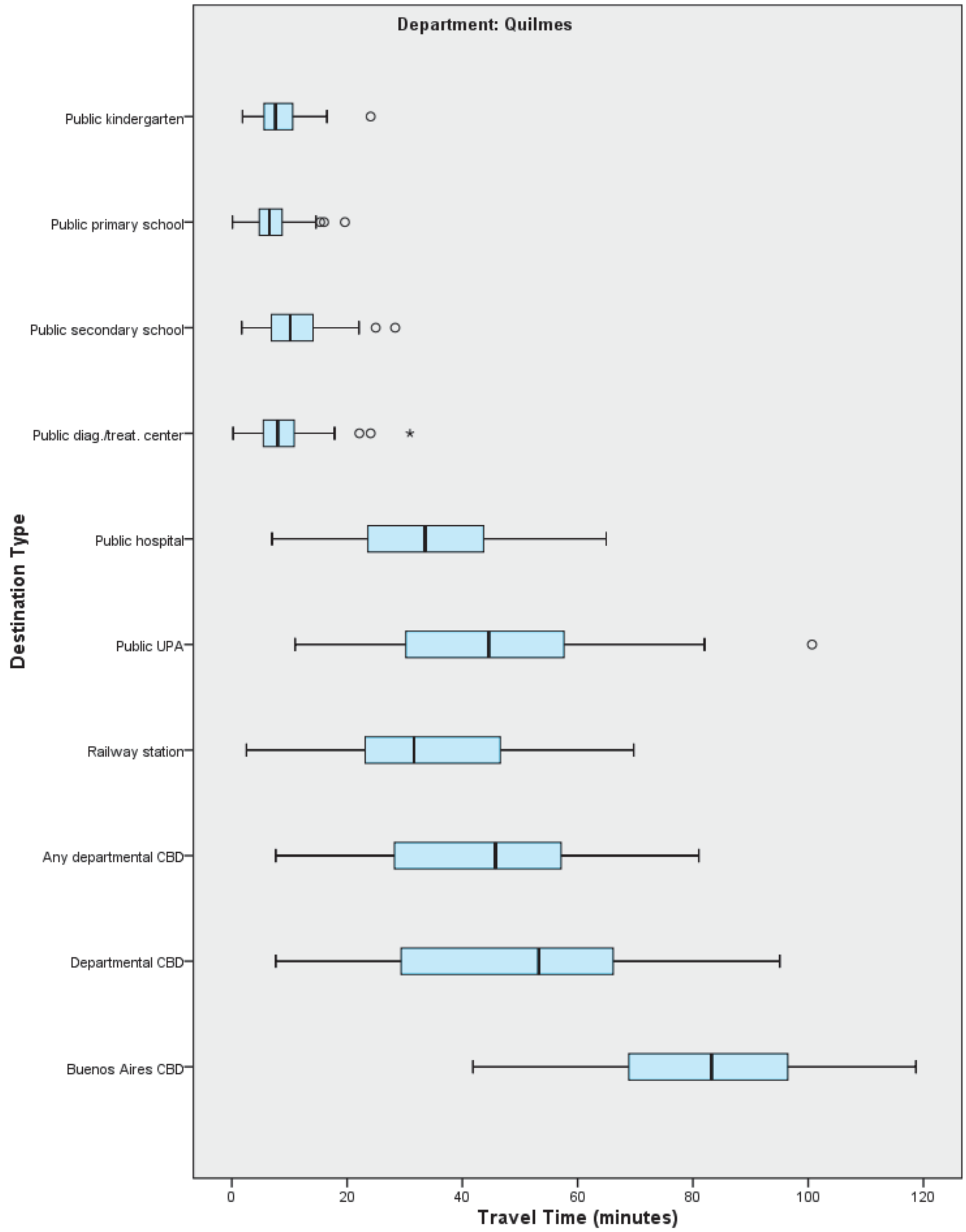


Figure 7.3: Box plots showing the distribution of travel times on public transportation, from all sampled census radios in Quilmes to all destination types

Of most interest, however, are the travel times disaggregated based on their census radio of origin and whether it contains an *asentamiento*. Consulting **Figure 7.4,** Quilmes' majority-overlap radios enjoy the longest travel times for nearly all destination types. Compared with radios with no-overlap, those with majority-overlap have markedly longer travel to all six of the first activity sites (CBD's, railroad stations, UPA's, and hospitals) with marginally-worse access to primary and secondary schools. Those with minority-overlap are also worse than their no-overlap counterparts in each of those same categories, save the urgent care units. Looking at just raw travel times, the schools all showed similar average travel times, as was seen when considering all the study areas together. The gaps that exist between the majority- and minority-overlap radios and the no-overlap radios, while still noticeable, are smaller than AGBA overall, with the difference hovering around fifteen minutes.

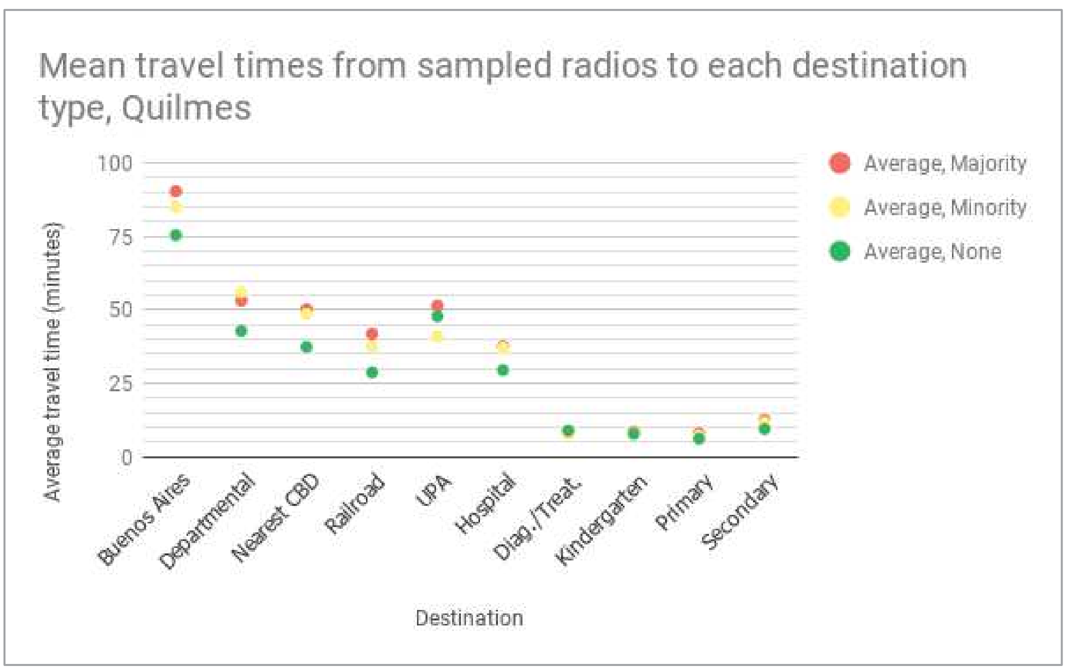


Figure 7.4: Graph of the average expected travel times on public transportation, to all destination types and from all sampled census radios in Quilmes, ordered by degree of overlap with an *asentamiento*

These differences are clearly apparent on the travel time maps (**Figure B.1-10**) for Quilmes. The largest circles are red and yellow on those for CBD's (**B.1-3**), urgent care centers (**B.5**), and hospitals (**B.6**). In a few cases, like the hospitals, UPA's, and railway stations (**B.4**), there are still some no-overlap radios with long travel, indicating that there are people in traditional neighborhoods with long trips, too. The schools and diagnostic/treatment centers (**B.7-10**) all showed low travel times across the board, with few places exceeding 30 minutes. Nonetheless, those few radios with these longer trips tended to be those with some degree of overlap with an *asentamiento*.

Table 7.5 contains the results of the difference-of-means tests for Quilmes. Looking first to the ANOVA tests, the F-statistic was very highly significant (99%) for two categories (the Buenos Aires CBD and the railroad stations), highly-significant (95%) for three (Quilmes' CBD, the nearest departmental CBD, and public hospitals), and moderately-significant (90%) for one (secondary schools). The remaining four were insignificant. These results provide initial evidence, at least for the very-highly- and highly-significant destinations, to support the hypothesis that the *asentamientos* enjoy poor relative accessibility to those attractions. For these five we can reject the null hypothesis that the independent samples (majority-, minority- and no-overlap radios) came from the same population.

Table 7.5: Results of ANOVA and independent-sample t-tests, travel times from the sampled census radios from all three case studies, delineated by degree of overlap with an *asentamiento*, to all destination types

Samples of Comparison	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
ANOVA											
Majority, Minority, None	F-statistic	**5.52**	**3.69**	**4.79**	**6.00**	**1.88**	**3.89**	**0.34**	**0.15**	**1.78**	**3.04**
	p(F)	0.01	0.03	0.01	0.00	0.16	0.02	0.72	0.86	0.17	0.05
T-Tests											
Any vs. None	t-statistic	**3.17**	**2.70**	**3.10**	**3.33**	**-0.81**	**2.80**	**-0.66**	**2.44**	**1.79**	**0.47**
	p(t)	0.00	0.01	0.00	0.00	0.42	0.01	0.51	0.02	0.08	0.64
	Mean diff.	11.43	12.09	11.79	10.30	-3.28	7.68	-0.67	2.54	1.26	0.39
	St. Err. (diff.)	3.61	4.48	3.80	3.09	4.05	2.74	1.02	1.04	0.71	0.82
Majority vs. Minority/ None	t-statistic	**2.29**	**0.84**	**1.59**	**2.30**	**1.18**	**1.33**	**0.13**	**1.48**	**1.37**	**0.48**
	p(t)	0.03	0.40	0.12	0.02	0.24	0.19	0.89	0.14	0.17	0.63
	Mean diff.	11.15	5.15	8.27	9.66	6.27	4.97	0.18	2.07	1.29	0.52
	St. Err. (diff.)	4.88	6.12	5.20	4.20	5.32	3.74	1.34	1.40	0.94	1.08
Majority vs. Minority	t-statistic	**1.10**	**-0.42**	**0.25**	**1.04**	**1.51**	**0.10**	**0.47**	**0.40**	**0.63**	**0.31**
	p(t)	0.28	0.68	0.80	0.31	0.14	0.92	0.64	0.69	0.54	0.76
	Mean diff.	5.37	-2.75	1.43	4.33	10.46	0.40	0.74	0.67	0.66	0.36
	St. Err. (diff.)	4.88	6.57	5.74	4.17	6.91	4.22	1.59	1.68	1.06	1.17
Minority vs. None	t-statistic	**2.30**	**2.62**	**2.74**	**2.53**	**-1.48**	**2.53**	**-0.76**	**2.02**	**1.35**	**0.29**
	p(t)	0.02	0.01	0.01	0.01	0.15	0.01	0.45	0.05	0.18	0.77
	Mean diff.	9.56	13.05	11.29	8.80	-6.91	7.54	-0.93	2.30	1.03	0.26
	St. Err. (diff.)	4.15	4.99	4.12	3.48	4.66	2.98	1.23	1.14	0.77	0.90
Majority vs. None	t-statistic	**2.88**	**1.59**	**2.30**	**2.87**	**0.58**	**2.02**	**-0.15**	**2.10**	**1.65**	**0.51**
	p(t)	0.01	0.12	0.03	0.01	0.57	0.05	0.88	0.04	0.10	0.61
	Mean diff.	14.93	10.30	12.72	13.13	3.54	7.95	-0.19	2.98	1.69	0.62
	St. Err. (diff.)	5.19	6.46	5.53	4.57	6.08	3.94	1.23	1.42	1.03	1.22

99% confidence = ■, 95% significance = ■, 90% significance = ■

For all five activity sites that returned highly-significant F-statistics, the t-tests indicate that most of the variation between those three independent samples was between the radios with (a) majority- and minority-overlap and (b) those without any. Very highly significant differences were registered between the any- and no-overlap radios for all five activities (e.g., CBDs, railway stations, and hospitals), with very-highly- or highly-significant differences recorded individually between the majority- and minority-overlap radios and those with no-overlap. The differences within the minority- and minority-overlap radios were insignificant. Strong evidence is thus found that there is an inequality in transit-facilitated access to CBD's, public hospitals, and railway stations between Quilmes' *asentamientos* and their neighbors. Confidence is strong for travel to the Buenos Aires CBD and to railway stations since the largest differences are for those majority-overlapped radios where we can be most certain *asentados* are living.

As for the other five activity sites—UPA's, diagnostic/treatment centers, and all three schools—these seem to be more equitably transit-accessible. The two healthcare attractions, alongside primary schools, showed no significant differences, whereas secondary schools, curiously, only showed a mildly-significant difference (90%) for the ANOVA tests, with nothing at any other level. The most interesting of these classes are kindergartens: ANOVA showed very little variance between the three primary classes (minority-, majority-, and no-overlap) but then showed highly-significant differences between the no-overlap radios and those with minority, majority, and any overlap.

While Quilmes' relatively-compact size produces absolute travel times shorter than what will be seen for the radios in La Matanza or Pilar, inequalities are nonetheless present between its *asentados* and their neighbors. Differences are greatest when considering travel to hypothesized employment/commercial-centers like central business districts and railway stations.

Section 7c: La Matanza

Table 7.6 contains descriptive statistics for the travel times estimated for La Matanza's sample of 120 census radios.

Table 7.6: Descriptive statistics for travel times on public transportation, from all sampled census radios in La Matanza to all destination types

Sample	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
All (120)	Average	**129.5**	**79.7**	**78.1**	**37.6**	**55.2**	**55.2**	**17.4**	**9.8**	**8.9**	**9.4**
	St. Dev.	40.5	47.4	47.4	33.0	19.4	35.5	11.1	7.1	7.5	7.9
	Minimum	57.8	2.2	2.2	7.1	9.2	1.5	1.2	0.1	0.1	0.1
	Maximum	274.6	232.6	232.6	182.6	129.6	195.9	72.5	40.2	42.5	42.4
Majority (30)	Average	**143.4**	**96.8**	**95.9**	**46.0**	**52.6**	**64.9**	**18.2**	**10.2**	**10.2**	**9.7**
	St. Dev.	35.8	40.1	40.6	35.4	20.5	34.6	9.4	7.9	8.5	8.3
	Minimum	103.3	48.6	48.6	12.7	17.7	16.6	4.1	2.8	2.8	2.9
	Maximum	274.6	232.6	232.6	182.6	129.6	195.9	39.0	40.2	42.4	42.5
Minority (30)	Average	**143.8**	**102.9**	**99.0**	**48.2**	**55.5**	**72.4**	**21.9**	**12.8**	**13.0**	**12.6**
	St. Dev.	40.5	43.9	45.9	35.7	17.6	32.2	10.6	7.3	7.7	7.3
	Minimum	94.0	35.4	35.4	11.3	20.3	28.1	4.0	0.9	1.5	1.6
	Maximum	239.1	198.8	198.8	133.9	91.4	157.9	42.8	36.2	34.5	34.4
Any Overlap (60)	Average	**143.6**	**100.0**	**97.5**	**47.1**	**54.1**	**68.8**	**20.1**	**11.5**	**11.6**	**11.1**
	St. Dev.	38.0	41.9	43.1	35.3	18.9	33.3	10.1	7.6	8.2	7.9
	Minimum	94.0	35.4	35.4	11.3	17.7	16.6	4.0	0.9	1.5	1.6
	Maximum	274.6	232.6	232.6	182.6	129.6	195.9	42.8	40.2	42.4	42.5
No Overlap (60)	Average	**115.8**	**60.1**	**59.4**	**28.5**	**56.2**	**42.1**	**14.8**	**8.0**	**7.2**	**6.7**
	St. Dev.	38.3	44.3	44.1	28.1	19.9	32.7	11.5	6.2	6.9	6.3
	Minimum	57.8	2.2	2.2	7.1	9.2	1.5	1.2	0.1	0.1	0.1
	Maximum	238.7	193.7	193.7	128.7	86.2	155.4	72.5	39.8	41.9	34.4

Of the three cases, La Matanza exhibits the widest ranges of travel times, with values as low as less than five minutes to some as great as three hours. La Matanza is an interesting case, as reflected by its INDEC agglomeration classification. It is part of the area traditionally considered to be "greater Buenos Aires" but, unlike some of its contemporaries (like Quilmes), it is not fully urbanized and, therefore, not entirely part of agglomerated Buenos Aires. As noted by Keeling (1996), La Matanza is one of the departments that "still have land available for ranching, agriculture, or leisure (p. 49)." A large territory, it extends from the border of CABA off towards the southwest. As of 2010, it had the largest population of any department within AGBA.

Within its expansive territory, La Matanza represents contrasting sides of development in Buenos Aires' periphery: urbanization to the east and agrarian lands to the west. Located along the La Matanza River, which forms its south-western boundary, there are over one million people living in its eastern half. Its citizens are primarily from the middle- and working-classes, with many commuting into service-sector jobs in CABA or working in one of the district's many factories and industrial centers. Keeling (1996) remarks that the development of the eastern half of the district closely followed the railroad, with the highest densities around its railway stations. These neighborhoods, he notes, follow a pronounced grid pattern. The other half of the district is sparsely populated, with open land dedicated to agriculture and horticulture. Departmental growth has been continual, with its population increasing from 700,000 in 1970 to 1 million in 1990, and 1.8 million by 2010 (Keeling 1996, p. 50; INDEC 2010).

This east-west dichotomy is visible on the map of *asentamientos* in La Matanza (**Figures 6.7a-b**). There are none in its northern or eastern quadrants, the most densely-populated part of the department. All the vacant land in this part of the district was presumably occupied by working-class neighborhoods long ago in Buenos Aires' history. All its precarious settlements, therefore, are in the southern portion of the department, far from its active railway lines and the provincial highway running down its length. In fact, those on the southeastern edge of the department are up against its namesake river, exemplifying how *asentados* commonly live in flood-prone territory. The peripheral nature of the *asentamientos* is accentuated in La Matanza, where residents are away from its core and isolated from centrally-located commercial/employment opportunities. If La Matanza was split into two separate departments, as might seem necessary given its large size, a northern department would probably have travel times more like Quilmes whereas a southern contemporary would resemble newly-urbanizing departments like Pilar. With such a large territory, featuring such a vast range of urban geographies, it is hard to say if La Matanza's results would be similar to those for departments of a similar degree of urbanization that are also more compact in size (e.g. Merlo, Almirante Brown).

With such a large expanse, it is not surprising to see such huge variances in travel times in La Matanza (**Figure 7.5** shows the corresponding box plots). Travel times to the central business districts, for instance, range from less than fifteen minutes all the way up to four hours. Public hospitals displayed a similar variance, whereas UPA's and railway stations, relative to other well-dispersed feature types, were more quickly accessed. An illustration of the department's large size, there are several radios requiring more than three hours' time on public transportation for their resident to reach the municipal center of their own department! While people in these locations may not need to make such journeys often (perhaps only for governmental issues requiring travel to municipal offices), such a trip is undoubtedly a burden, especially to someone with no other mobility options. Schools and diagnostic/treatment centers, however, featured the shortest travel times of any activity type, with few travel times above sixty minutes. All destination types showed numerous outliers with pronounced rightward skews.

The range of travel times is clearly visible on the travel maps for La Matanza's census radios (**Figures C.1-10**). Circles depicting the radios in the densely-populated north are consistently much smaller than their counterparts to the south; some of the longest travel times across all three study areas are found in this part of La Matanza. The relative disadvantage, accessibility-wise, of these radios is most clear on the figures showing travel to CBD's (**C.1-3**) and hospitals (**C.6**).

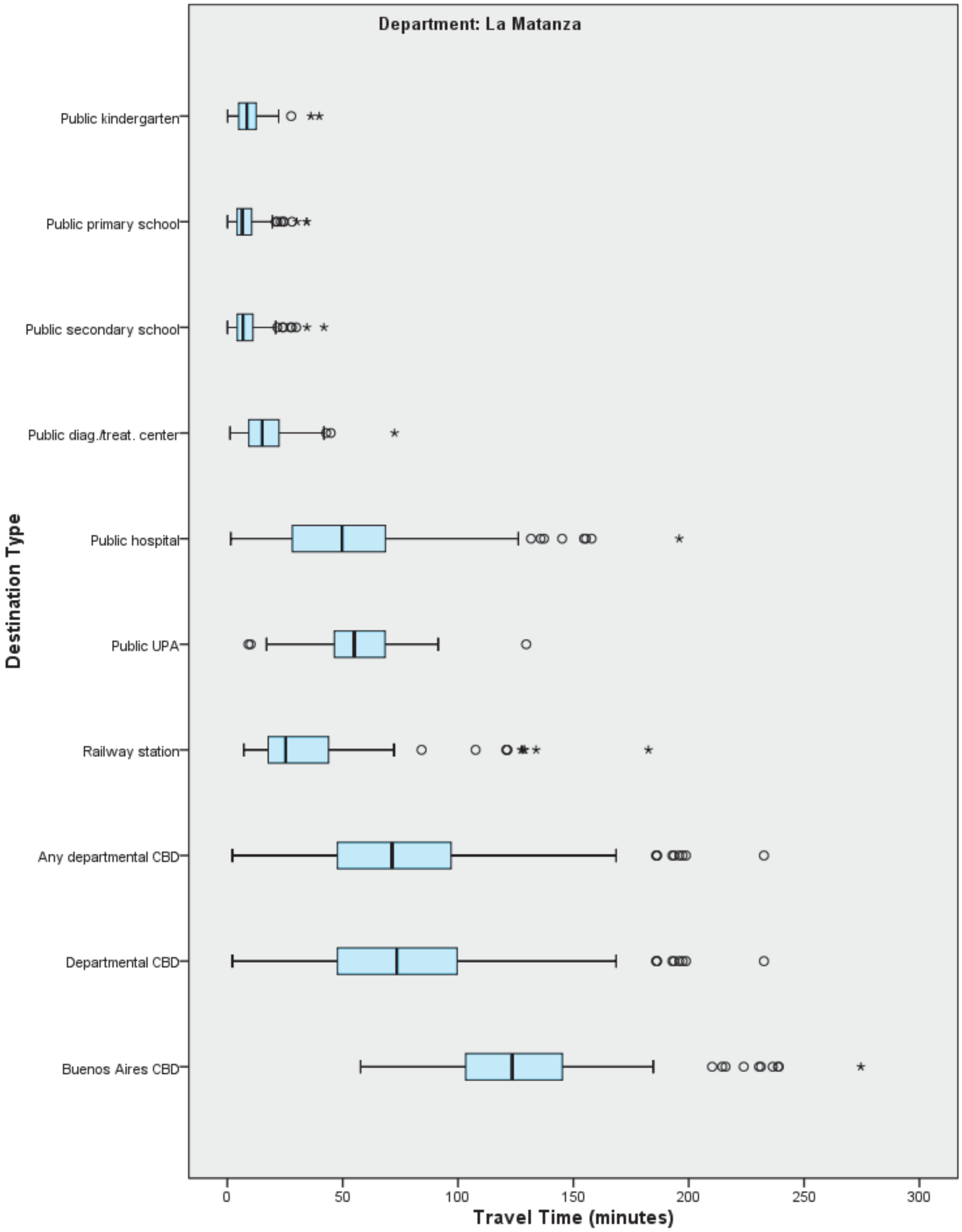


Figure 7.5: Box plots showing the distribution of travel times on public transportation, from all sampled census radios in La Matanza to all destination types

Like Quilmes, the most pertinent findings for La Matanza concern travel times for the different census radio categories (**Figure 7.6**). In some ways, the results are like Quilmes', with the majority- and minority-overlap radios showing markedly higher expected travel times across most of the categories: twenty to thirty additional minutes of travel are required to most destinations (e.g., the CBDs, railroad stations, and public hospitals) for people living in a radio that overlaps with an *asentamiento*. Values are higher, although by a smaller absolute margin, for trips to schools or diagnostic/treatment centers. The only exceptions, curiously, are travel times to urgent care centers, which are *longer* for non-*asentados*. These results tentatively confirm the project hypothesis.

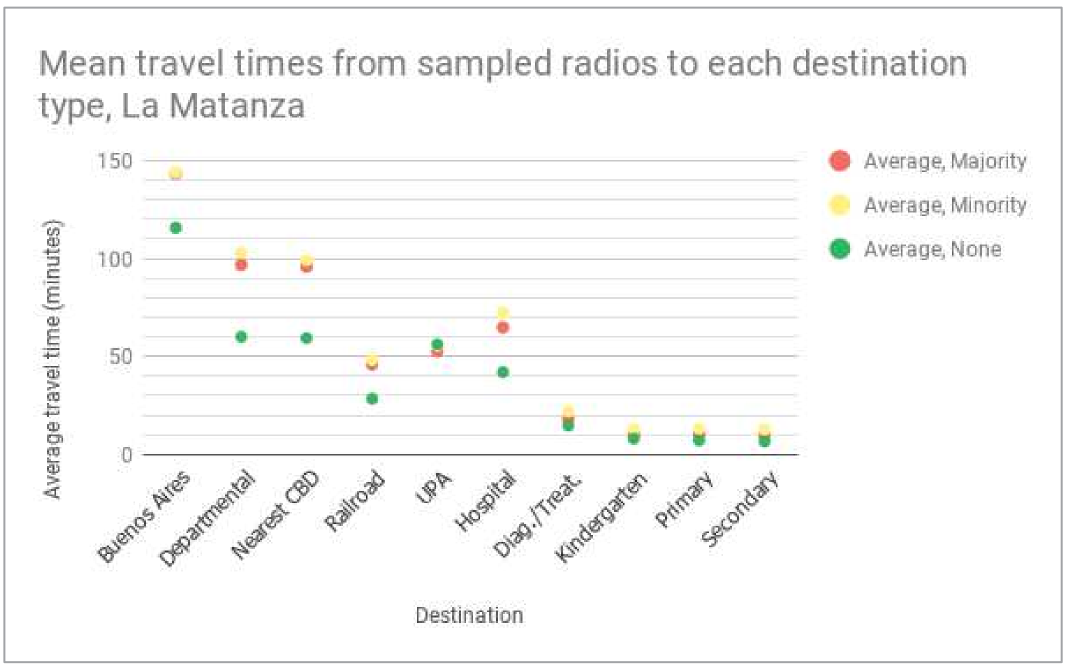


Figure 7.6: Graph of the average expected travel times on public transportation, to all destination types and from all sampled census radios in Quilmes, ordered by degree of overlap with an *asentamiento*

The statistical tests, whose results are shown in **Table 7.7**, provided overwhelming evidence of access inequalities in La Matanza. The ANOVA tests produced very highly-significant (99% confidence) F-scores for eight of the ten destination categories and a highly-significant statistic (95%) for another. The outliers are the urgent care units, which showed little-to-no difference between the three study samples: majority-, minority-, and no-overlap census radios.

The t-tests indicate that the differences-of-means specifically contributing to the high ANOVA scores are between radios of any- (whether minority *or* majority) and no-overlap. The t-tests for any-versus-none and minority-versus-none are very-highly significant (99%) for all destination categories. For hospitals, CBDs, and railroad stations, the majority-versus-none distinction was still highly-significant (95%+). The majority-versus-minority difference was insignificant across the board.

These trends are discernable on the travel time maps for La Matanza. For instance, majority- or minority-overlap radios (shown in red and yellow, respectively) are clearly the largest circles on several of the maps: the department's CBD (**C.2**), any department's CBD (**C.3**), railways (**C.4**), and public hospitals (**C.6**). While the majority- and minority-overlap radios have long travel times for some of the other features (like Buenos Aires' CBD, **C.1**, and each of the schools, **C.8-10**), the differences are not as noticeable, with many no-overlap radios in the center of the department showing exceptionally long, too. Even in cases where the absolute travel times were not as long, like the diagnostic/treatment centers (**C.7**), the longest relative times are still for radios with any-overlap. The unique pattern for the UPA's (**C.5**), meanwhile, is reflected in its spatial distribution; this is the only destination type where the largest circles (90+ minutes of travel, in this case) were either green or located in the northern half of La Matanza.

Table 7.7: Results of ANOVA and independent-sample t-tests,
travel times from the sampled census radios from all three case studies,
delineated by degree of overlap with an *asentamiento*, to all destination types

Samples of Comparison	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
ANOVA											
Majority, Minority, None	F-statistic	7.79	12.68	11.19	5.05	0.33	10.04	4.46	4.78	7.16	6.12
	p(F)	0.00	0.00	0.00	0.01	0.72	0.00	0.01	0.01	0.00	0.00
T-Tests											
Any vs. None	t-statistic	**3.97**	**5.03**	**4.74**	**3.18**	**-0.60**	**4.40**	**2.66**	**3.17**	**3.42**	**2.70**
	p(t)	0.00	0.00	0.00	0.00	0.55	0.00	0.01	0.00	0.00	0.01
	Mean diff.	27.83	39.88	38.07	18.63	-2.14	26.74	5.27	4.38	4.45	3.44
	St. Err. (diff.)	7.02	7.94	8.03	5.86	3.58	6.07	1.98	1.38	1.30	1.27
Majority vs. Minority/ None	t-statistic	**2.12**	**2.23**	**2.32**	**1.54**	**-0.80**	**1.68**	**0.44**	**0.62**	**0.66**	**0.35**
	p(t)	0.04	0.03	0.02	0.13	0.43	0.10	0.66	0.54	0.51	0.73
	Mean diff.	18.24	22.51	23.33	10.94	-3.35	12.76	1.03	1.03	1.03	0.53
	St. Err. (diff.)	8.63	10.08	10.08	7.11	4.20	7.62	2.35	1.66	1.57	1.51
Majority vs. Minority	t-statistic	**-0.05**	**-0.54**	**-0.27**	**-0.23**	**-0.57**	**-0.85**	**-1.45**	**-1.35**	**-1.44**	**-1.34**
	p(t)	0.96	0.59	0.79	0.82	0.57	0.40	0.15	0.18	0.16	0.18
	Mean diff.	-0.46	-6.01	-3.03	-2.18	-2.84	-7.47	-3.73	-2.83	-2.90	-2.64
	St. Err. (diff.)	10.07	11.07	11.41	9.34	5.01	8.78	2.58	2.09	2.02	1.96
Minority vs. None	t-statistic	**3.22**	**4.33**	**3.96**	**2.86**	**-0.18**	**4.17**	**2.84**	**3.60**	**3.98**	**3.22**
	p(t)	0.00	0.00	0.00	0.01	0.86	0.00	0.01	0.00	0.00	0.00
	Mean diff.	28.05	42.78	39.54	19.68	-0.77	30.35	7.14	5.80	5.90	4.75
	St. Err. (diff.)	8.72	9.87	10..00	6.89	4.29	7.27	2.51	1.61	1.48	1.47
Majority vs. None	t-statistic	**3.21**	**3.74**	**3.71**	**2.50**	**-0.78**	**3.00**	**1.40**	**1.77**	**1.91**	**1.40**
	p(t)	0.00	0.00	0.00	0.01	0.44	0.00	0.17	0.08	0.06	0.17
	Mean diff.	27.59	36.77	36.50	17.50	-3.60	22.88	3.41	2.96	3.00	2.12
	St. Err. (diff.)	8.58	9.84	9.84	7.01	4.60	7.62	2.43	1.67	1.57	1.52

99% confidence = , 95% significance = , 90% significance =

These results provide strong evidence in favor of transit-based access inequalities within La Matanza department. For nine of ten activity sites, census radios containing some proportion of an *asentamiento* displayed significantly longer travel times. When it comes to accessibility vis-à-vis CBDs, public hospitals, and railway stations, some of the most significant gaps are for those radios that most likely containing *asentados* (i.e., majority overlap). These findings support the thesis' hypothesis even more strongly than Quilmes'. The fully-urbanized layout of Quilmes appears to aid the relative accessibility of its *asentamientos*, which had statistically-significant worse travel times for a smaller number of destination types. La Matanza's urban history and size have meant that all its leftover land, therefore available for settlement, are situated much more peripherally than the equivalent spaces in Quilmes. While *asentados* in Quilmes nonetheless settled on poor-quality lands along highways and creeks, these spaces—thanks to the department's compact size and widespread transit coverage—were never as far-removed from its urban amenities as in La Matanza. Even though its geography inherently prolongs trips for all its residents, the longest trips in the latter department are still overwhelmingly made by its most marginalized people. La Matanza's transportation network, which played a defining role in its initial settlement patterns, appears to be neglecting the mobility needs of many of its inhabitants.

Section 7d: Pilar

Table 7.8 contains descriptive statistics for the travel times calculated for Pilar's sample of seventy-two census radios.

Table 7.8: Descriptive statistics for travel times on public transportation, from all sampled census radios in Pilar to all destination types

Sample	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
All (72)	Average	**134.3**	**59.7**	**49.1**	**29.5**	**106.1**	**41.5**	**17.9**	**15.9**	**16.8**	**15.9**
	St. Dev.	34.0	33.2	20.8	12.4	39.9	16.7	11.1	11.6	12.3	12.0
	Minimum	95.7	3.0	3.0	7.5	35.4	10.4	2.7	1.7	1.7	0.8
	Maximum	240.6	148.7	116.0	54.3	188.5	111.4	57.1	57.5	54.9	50.6
Majority (6)	Average	**117.6**	**78.8**	**57.4**	**26.2**	**91.9**	**48.4**	**10.1**	**8.8**	**12.4**	**11.1**
	St. Dev.	10.3	42.1	9.6	6.4	37.5	7.6	3.5	3.4	5.4	5.7
	Minimum	104.1	45.4	45.4	16.1	48.7	37.6	6.6	3.6	6.8	6.0
	Maximum	134.2	133.7	69.8	33.8	128.2	58.5	14.7	13.7	21.4	21.4
Minority (30)	Average	**144.1**	**55.0**	**50.9**	**33.2**	**106.5**	**45.7**	**18.5**	**16.0**	**16.8**	**17.1**
	St. Dev.	38.3	21.5	15.1	12.5	47.4	10.8	10.3	9.2	11.4	12.2
	Minimum	106.0	19.0	19.0	12.3	35.4	18.9	2.7	2.4	1.7	1.8
	Maximum	240.6	105.4	77.8	54.3	188.5	63.3	43.1	41.3	42.3	49.1
Any Overlap (36)	Average	**138.8**	**59.6**	**52.1**	**31.9**	**103.6**	**46.2**	**17.1**	**14.8**	**16.0**	**16.1**
	St. Dev.	36.1	27.5	14.3	11.9	45.4	10.2	10.0	8.9	10.7	11.5
	Minimum	104.1	19.0	19.0	12.3	35.4	18.9	2.7	2.4	1.7	1.8
	Maximum	240.6	133.7	77.8	54.3	188.5	63.3	43.1	41.3	42.3	49.1
No Overlap (36)	Average	**129.8**	**59.8**	**46.1**	**26.9**	**108.7**	**36.7**	**18.8**	**17.1**	**17.5**	**15.6**
	St. Dev.	31.8	38.6	25.7	12.7	34.1	20.4	12.3	13.9	13.9	12.6
	Minimum	95.7	3.0	3.0	7.5	50.9	10.4	4.3	1.7	2.2	0.8
	Maximum	203.0	148.7	116.0	54.0	187.7	111.4	57.1	57.5	54.9	50.6

The range of travel times in Pilar falls between Quilmes and La Matanza, curious given that Pilar is not traditionally part of Greater Buenos Aires. In fact, it is primarily suburban, with large areas still dedicated to agriculture. The ranges for destination-specific travel times to CBD's, public hospitals, and railway stations were not nearly as large as those for La Matanza. Almost all trips from the census radios sampled in Pilar were under two hours. Like Quilmes and La Matanza, however, trips to schools and diagnostic/treatment centers were relatively invariant and short, with over an hour. The biggest difference between Pilar and the other study sites, however, was the distribution of travel times to the urgent care centers. Values are all greater than forty-five minutes, with some past three hours—hardly useful for urgent care! Nevertheless, few of the destinations display highly-skewed distributions with few outliers.

The history of Pilar, however, makes these results somewhat surprising. Pilar is perhaps the most distinctive of the three case studies, at least from an urban-geographic perspective. Frequently cited as the epitome of socio-economic spatial inequality in Buenos Aires, it hosts contrasting ends of the region's socioeconomic spectrum: wealthy gated communities and impoverished squatter settlements. After the upgrade of its highway (see **Figures 6.8a-b**) during the 1990s, Pilar saw a boom of gated neighborhoods. Built on former agricultural land, upper- and middle-income *porteños* moved into these North American suburb-style developments. Immense growth came to a department that previously had been nothing more than a few small towns settled around railway stations at the far end of one of Buenos Aires' commuter railway lines.

As more suburbs were constructed, other types of low-density development have followed: industrial plants, office parks, shopping centers, and private universities are but a few examples. Furthermore, these amenities were constructed away from the department's previous railway-centric urban centers. Instead, these new developments sprang up near the exits of the highway. These sites strategically catered to families living in the gated communities found along the arterial roads that intersected the highway as well as white-collar commuters who would stop at these roadside attractions as part of their drives to and from jobs in CABA. According to Keeling (1996), Pilar experienced 50% growth between 1980 and 1991; its population was 47,000 in 1970 and is now over 200,000 (p. 46; INDEC 2010). While these private housing developments provided their own residents with utilities, any communities outside of their walls have seen little benefit, with many lacking clean water, telephone service, and sewerage. **Table 6.4** showed how Pilar had the lowest rates of service provision of the three study areas, despite some of the highest rates of car ownership and university education. In fact, several *asentamientos* have appeared nearby gated communities as housing for people seeking low-skill, low-income employment in the gated communities and other service-sector jobs that have followed families into Buenos Aires' new suburbs.

In terms of transportation, all the newest developments are automobile-centric, with large distances separating housing units, shopping centers, and employment sites (Blanco 2014). With most of the new development taking place away from the handful of historic towns along Pilar's railway, even the residents of its longest-established nucleations face lengthy trips. Bus and commuter rail services are additionally low-quality and infrequent. Blanco and Apaolaza (2018) noted that automobile licenses are uncommon among low-income people in Pilar, implying a forced dependence on these unreliable public modes of travel. Furthermore, walking and biking are not options given the prioritization of automobiles on local streets and the great distances separating low-income housing from the entrances and driveways of the sprawling gated communities where they go to work (De Duren 2006; Blanco 2014). **Figures 7.7a-l** contain photos of some of Pilar's new developments, taken by the author in August 2017.

Figure 7.7a: The entrance to one gated community, known as "Villa del lago" ("Villa of the lake")

Figure 7.7b: Shopping center along Pilar's highway, with a Burger King restaurant to the right

Figure 7.7c: A wall in front of another gated community, with the English name "Pilar Village"

Figure 7.7d: A small strip-mall commercial development, with parking for automobiles in front

Figure 7.7e: One of the factories in Pilar's highway-adjacent industrial park, constructed during the 1990s

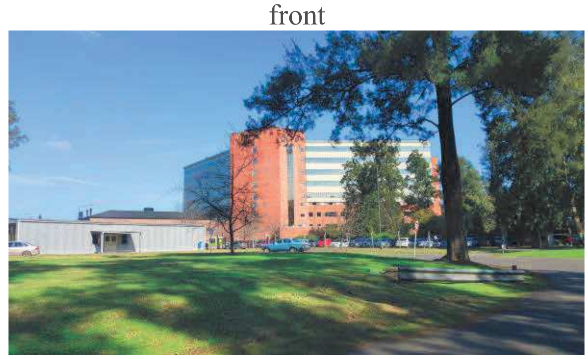


Figure 7.7f: A large private university in Pilar

Figure 7.7g: A public bus near one of the main railway stations in Pilar

Figure 7.7h: Entrance to another gated community, known as “La Delfina”

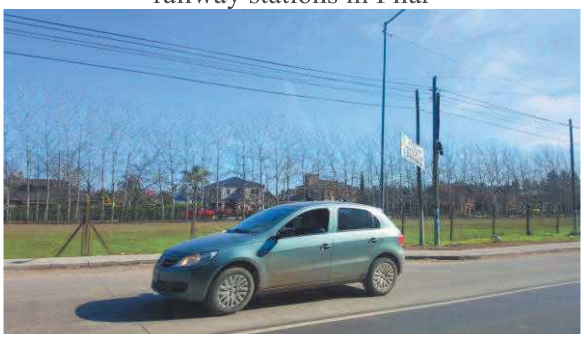


Figure 7.7i: Private car on an arterial route in Pilar with suburban homes in the background

Figure 7.7j: Bus stop with shelter along arterial road in Pilar with suburban homes in background

Figure 7.7k: Mercedes-Benz dealership in what appears to be a former church, Pilar

Figure 7.7l: New commercial development, with parking garage, along Buenos Aires-Pilar highway

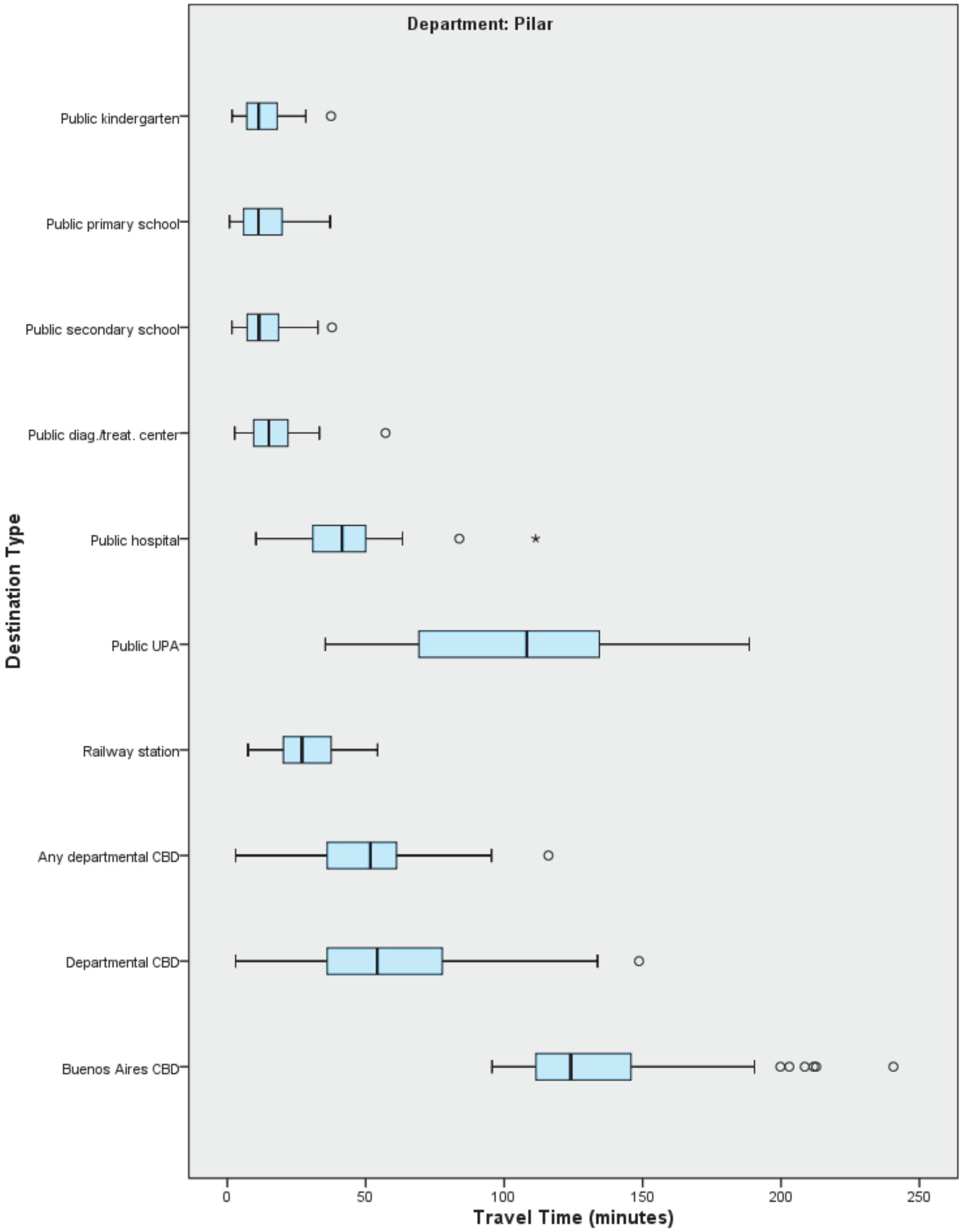


Figure 7.8: Box plots showing the distribution of travel times on public transportation, from all sampled census radios in Pilar to all destination types

The variation in travel times from the different radios in Pilar (**Figure 7.9**) was initially unexpected. Those radios with no-overlap enjoy worse transit-based access to six of the ten destination types (Buenos Aires CBD, UPA's, diagnostic/treatment centers, and all schools). Radios with majority-overlap have the longest travel times to only two destination categories (departmental CBD and nearest CBD). Conversely, all radio-overlap categories require essentially the same amount of time to access railroad stations and public hospitals. Minority-overlap radios more closely parallel those with no-overlap, with similar accessibility to all amenities. Compared with Quilmes and La Matanza, these results are quite odd—how could the *asentados* have *better* access than their neighbors? Examining the department's socio-economic geography, however, contextualizes these results, as well as the corresponding difference-of-means tests.

Travel time maps for Pilar, **Figures D.1-10**, illustrate these unusual findings. In contrast the maps for Quilmes and La Matanza, the largest circles (indicative of longer travel times) are nearly always green (no-overlap) or yellow (minority-overlap), with values generally higher further away one goes from the railway lines or highways. Contrary to the *asentamientos* in those departments that are more agglomerated, Pilar's majority-overlap radios have better relative transit-facilitated access to almost all destination types (CBD's, railway stations, health care, and schools). The only exception is access to Pilar's own central business district (**D.2**). Even with amenities like schools, where absolute travel times are not particularly long, the longest trips (i.e., 45+ minutes) are for radios with no-overlap. At the same time, all radios, regardless of overlap, required substantial travel to reach an urgent care center (**D.5**). Comparing these maps with those from La Matanza (**C.1-10**) reveals a remarkable contrast. Unlike La Matanza, where *asentamientos* are exclusively found along the department's boundaries (and far away from its main nucleations), those in Pilar are much more centrally-located. Rather than leftover for informal settlement, Pilar's isolated spaces are its *preferred* spaces.

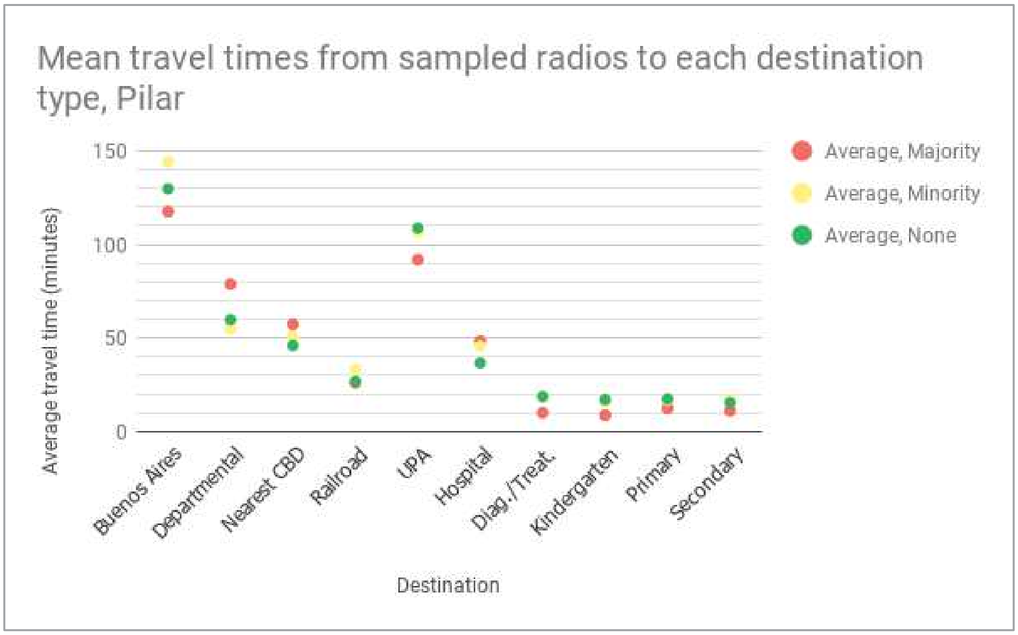


Figure 7.9: Graph of the average expected travel times on public transportation, to all destination types and from all sampled census radios in Pilar, ordered by degree of overlap with an *asentamiento*

Consulting the test results in **Table 7.9**, *none* of the ten ANOVA tests returned very highly or highly significant (99%, 95%) F-statistics; only one, public hospitals, returned a value of moderate-significance (90%). This contrasts with the other study areas, as well as the three case studies together, which all exhibited big differences in travel time from their respective majority-, minority-, and no-overlap samples.

Table 7.9: Results of ANOVA and independent-sample t-tests, travel times from the sampled census radios from all three case studies, delineated by degree of overlap with an *asentamiento*, to all destination types

Samples of Comparison	Statistic	Buenos Aires CBD	Departmental CBD	Nearest CBD	Railroad Station	UPA	Hospital	Diag./Treat.	Kindergarten	Primary School	Secondary School
ANOVA											
Majority, Minority, None	F-statistic	2.08	1.25	0.88	2.15	0.43	2.72	1.63	1.33	0.64	0.42
	p(F)	0.14	0.30	0.42	0.13	0.65	0.07	0.20	0.27	0.53	0.66
T-Tests											
Any vs. None	t-statistic	**1.03**	**-0.02**	**1.14**	**1.63**	**-0.49**	**2.32**	**-0.62**	**-0.49**	**0.20**	**-0.86**
	p(t)	0.31	0.98	0.26	0.11	0.63	0.03	0.54	0.63	0.84	0.40
	Mean diff.	9.07	-0.21	6.03	5.08	-5.09	9.51	-1.66	-1.43	0.57	-2.35
	St. Err. (diff.)	8.77	8.51	5.28	3.12	10.36	4.10	2.67	2.92	2.84	2.74
Majority vs. Minority/ None	t-statistic	**-2.91**	**1.49**	**1.02**	**-1.14**	**-0.92**	**1.07**	**-1.82**	**-0.89**	**-1.01**	**-1.59**
	p(t)	0.01	0.14	0.31	0.28	0.36	0.29	0.07	0.38	0.32	0.12
	Mean diff.	-18.59	21.09	9.16	-3.58	-15.78	7.70	-8.49	-4.70	-5.14	-7.78
	St. Err. (diff.)	6.39	14.12	8.95	3.13	17.18	7.17	4.67	5.27	5.10	4.90
Majority vs. Minority	t-statistic	**-2.99**	**1.34**	**1.00**	**-1.95**	**-0.70**	**0.58**	**-1.94**	**-1.42**	**-1.86**	**-3.28**
	p(t)	0.01	0.23	0.33	0.07	0.49	0.57	0.06	0.18	0.08	0.00
	Mean diff.	-26.59	23.75	6.51	-7.00	-14.58	2.73	-8.34	-4.31	-6.00	-7.15
	St. Err. (diff.)	8.89	17.71	6.51	3.59	20.88	4.69	4.30	3.04	3.23	2.18
Minority vs. None	t-statistic	**1.51**	**-0.59**	**0.82**	**1.89**	**-0.19**	**1.98**	**-0.09**	**-0.22**	**0.51**	**-0.39**
	p(t)	0.14	0.56	0.42	0.06	0.85	0.05	0.93	0.82	0.61	0.70
	Mean diff.	14.39	-4.81	4.77	6.39	-2.17	8.98	-0.27	-0.71	1.57	-1.15
	St. Err. (diff.)	9.53	8.15	5.81	3.38	11.50	4.53	2.86	3.17	3.06	2.96
Majority vs. None	t-statistic	**-1.70**	**1.09**	**1.05**	**-0.17**	**-1.08**	**1.37**	**-1.69**	**-0.87**	**-0.84**	**-3.08**
	p(t)	0.10	0.29	0.30	0.86	0.29	0.18	0.10	0.39	0.40	0.00
	Mean diff.	-12.20	18.95	11.28	-0.61	-16.75	11.71	-8.61	-5.02	-4.43	-8.31
	St. Err. (diff.)	7.17	17.44	10.73	3.49	15.49	8.53	5.11	5.78	5.25	2.70

99% confidence = , 95% significance = , 90% significance =

The independent-sample t-tests add little support to the overarching hypothesis that there are inequalities in transit-facilitated access in the study areas. In fact, only four tests returned highly significant values, half of which were between majority- and minority-overlap radios. The fact that majority-overlap radios were on one side of some of the more significant tests adds some credence to the existence of inequalities in access to Buenos Aires' CBD and public secondary schools, although neither destination's travel times returned a significant F-statistic. A similarly inconclusive verdict can be drawn for access to public hospitals, which only display moderately- and highly-significant differences vis-à-vis its minority-overlap radios, which are less likely to fully represent *asentados* as their majority-overlap counterparts. If the greatest differences were between radios with any-overlap and those with no-overlap, the conclusion would be stronger. Otherwise, there is little evidence to suggest that the different travel time samples, each overlapping an *asentamiento* to a different degree, were drawn from distinct populations.

Considered relative to Quilmes and La Matanza, these findings are surprising. Pilar's socio-territorial configuration, however, provides significant context. For one, the sample of no-overlap radios includes many that are spatially distant from Pilar's main corridors of development, whether the historic railroad towns or new highway-centric commercial centers. As a result, they have inherently longer travel times than even the *asentamientos*, which are relatively centrally-located. Furthermore, these peripheral locations, typically large tracts of former farmland, are increasingly occupied by gated communities, whose residents do not require transit. Built for people with enough wealth to afford a car, they are intensively automobile-centric (Blanco 2014).

Given this situation, it might be easy to dismiss poor transit access in these areas as irrelevant or to suggest that access to public schools or healthcare sites does not even matter for such a wealthy clientele. Such conclusions, however, miss some vital distinctions. For one, these gated communities are still employment destinations for many, especially people from Pilar's *asentamientos* (De Duren 2006). While this project only simulates trips that originate from people's homes, it still has implications for trips in the other direction, especially in these unique cases where home sites in a gated community double as sites of residence *and* employment. That transit does not meaningfully serve these neighborhoods impedes its accessibility of those without cars.

This is an example of Blanco and Apaolaza's (2018) argument that accessibility is just as much about territory as it is about socio-economics: the same transportation system that advantages Pilar's drivers disadvantages its carless. It also invokes Handy and Neimeier's plea to carefully consider the measurement of travel impedance and the selection of destination types when analyzing accessibility. While gated community transit-based travel times are comparable with driving times to amenities preferred by their residents, such a juxtaposition is meaningless to *asentados*. Nevertheless, driving times would, at a minimum, provide some context to the transit-based access scores here, illustrative the relative disparity in accessibility between Pilar's distinct socio-economic communities. That an *asentado* can use transit to arrive in Buenos Aires' CBD twelve-minutes faster than the residents of a no-overlap radio means little when the people from the latter location can make the trip in a car in less than half the time.

While the statistics seem to show relative parity in transit-facilitated accessibility patterns in Pilar, inequalities are nonetheless present. Consideration must be given to the modes and amenities that pertain to different social groups and how accessibility manifests differently based on context. While Pilar is a glaring example of disparities in mobility and accessibility in AGBA, these problems nonetheless exist in Quilmes, La Matanza, CABA, and parts of the agglomeration, even if they materialize differently.

Chapter 8: Conclusions

In this thesis, I have shown that the accessibility needs of marginalized peoples living in the *asentamientos* of agglomerated Buenos Aires, Argentina are not being adequately met by the existing public transportation system. *Asentados* often need to travel much longer than their counterparts in formal neighborhoods to reach quotidian amenities like business districts, hospitals, railway stations, community healthcare, and schools. Their severity varying across the differentially-urbanized departments comprising AGBA, these inequities are the result of a complex network of geographic, historic, and socioeconomic variables connected to the *asentamientos*' spatially-peripheral locations. Land use patterns, government policies, activity site locations, macro-economic forces, transit route networks, and public transportation schedules have all further contributed to these regional problems of inequitable access. Those responsible for the provision of accessibility-enhancing mobility services must take heed.

Operationalizing accessibility is getting easier and more accurate thanks to new tools like Google's Distance Matrix API. Questions of inequitable access, like those posed by Buenos Aires' *asentamientos* vis-à-vis regional public transportation, can be answered more precisely than ever. With real time estimations of how long it takes to drive, ride transit, walk, or bike between any origin or destination, it is possible to prognosticate whether the people of any given city, region, or country can reasonably and effectively reach the places they need to go to carry out critical daily activities. By knowing this information, planners, policy makers, and academics can gain an understanding of where transportation systems are performing more efficiently and where they warrant improvement. Service inequities—where the provision of mobility services does not match the need or demand from citizens—can be discovered. Transit improvements can then be planned for where inequitable access has particularly pernicious implications for marginalized groups like the poor. Mapping these phenomena makes it possible to ensure that everyone—regardless of where they live—has the mobility assets, whether public or private, required to access the array of economic, social, and cultural benefits provided within their cities.

This is especially true in Buenos Aires, where there are substantial concerns that its urban poor, especially those living in its *asentamientos*, are further marginalized by a transportation system that unfairly limits their access to key opportunity sites while simultaneously promoting the mobility and accessibility of their fellow citizens. Cornered onto isolated pieces of land in response to hostile government housing policies and spatially-uneven economic growth, the provision of public transportation has been insufficient, especially as funding for transit has been slashed and operations privatized. A victim of the region's concurrent motorization trends, Buenos Aires' transit system has struggled to recover the loss of passengers to private automobiles. Rail and bus services are characterized by old equipment, crowded vehicles, and unreliable frequencies. Even though transit, and its ability to enhance accessibility, has deteriorated for people across the region, this thesis has shown that the transport services provided to *asentamientos*—nestled in Buenos Aires' periphery, with some of its most physically- and socioeconomically-disadvantage people—are indeed some of the conurbation's worst.

Using Google's data, this project has shown that these inequalities clearly exist within agglomerated Buenos Aires. After acquiring the required data, which involved querying the Distance Matrix API for estimations of the transit-based travel times between an assortment of origins and destinations (the former census geographies characterized by their spatial overlap with *asentamientos* and the latter a series of ten activity sites important to *asentados*), I performed a series of difference-of-means tests to surmise whether these times were longer for those geographies with *asentamientos* than those without. Tabulated for *asentamientos* sampled from three of AGBA's departments (each representing municipalities in different stages of urbanization), ANOVA and independent-means t-tests revealed that inequalities exist within the study area and that they vary by destination type and the urban morphology of each individual department.

Closer to agglomerated Buenos Aires' core, where departments are either fully urbanized (Quilmes) or mostly-urbanized (La Matanza), *asentamientos* have longer transit-travel times when accessing major commercial and employment centers (central business districts), public hospitals, and railway stations (which are part of the greater transportation system as well as local centers of commerce). On the other hand, activity sites like public schools and community medical centers are more equitably accessible, even if some had statistically-significant differences where absolute differences in the travel times between *asentados* and their neighbors were not great. For departments on AGBA's periphery, trends were the opposite, with few significant differences between those neighborhoods inside and outside of the *asentamiento*. In fact, some of its activity sites are *more* accessible to *asentados* than their traditional-neighborhood counterparts. These initially-surprising outliers, however, were a result of the socio-territorial landscape of Pilar, with its gated communities and auto-oriented commercial offices.

The different results for the three case study departments showcase a key takeaway of this project: accessibility and inequality must be considered vis-à-vis transportation and land use. This theme underlies the paper's primary conclusion:

Google's transit data show that the *asentamientos* of agglomerated Buenos Aires, within certain socio-territorial configurations of urban and suburban space, appear to enjoy inequitable transit-facilitated access to critical amenities and attractions.

Before any greater application of these results, this paper's assumptions must be addressed. For one, there is no easy way to verify the accuracy of these findings since they are based on *predicted* travel times. The theoretical route schedules obtained through Google cannot account for the actual day-to-day vagaries of congestion, overcrowding, and other common delays. As such, the travel times used in this study likely under-estimations. There are, however, no reliable alternative methods for calculating travel times without being able to track, in real time, actual travelers as they go about their daily activity patterns on the ground. Of similar concern, the results reflect access at only a handful of times during the day, missing diurnal travel variations. They also only reflect modes and destinations that apply to *asentados*; opportunities or modes that might be preferred by the "control group" (driving cars or attending private schools, for example) are missed, implying that my comparisons may reflect unrealistic traveler behaviors. Methodological improvements, like increasing the quantity of API requests or comparing travel times across modes or destinations, could ease these concerns.

There is one other methodological issue, also related the API, that must be noted. The API's output for transit-based travel time, as noted before, is merely a time value; it does not include the physical route of the trip nor any corresponding information on the number of legs on a trip, the mode of each leg, the number of transfers, the time of each leg, and whether any walking is required. Any travel time could reflect any combination of these elements. A thirty-minute trip could require twenty-five minutes of and five of riding the bus or vis-versa. There is no way to know. Such differences, like the amount of waiting or number of transfers, are *not insignificant* and probably have a substantial effect on accessibility, especially for vulnerable groups. Since most *asentamientos* have naturally longer travel times as a characteristic of their locations (and, as said before, it could be that this characteristic alone explains the observed inequalities), knowing the proportion of a trip that is comprised of walking or waiting (likely even worse) would help to greatly improve the picture of accessibility that has been captured.

Given these considerations, I am hesitant to make any concrete policy recommendations based on these results alone. The economic and political conditions that surround the provision of transit in Buenos Aires, especially in those peripheral regions that lack the direction of a strong planning authority, are more complex than I yet understand. Simple fixes like adjusting transit routes or introducing new travel modes are likely more complicated than would seem (or might be with a planning agency in the Global North). Previous studies and historiographies have shown that the effective formulation and implementation of transportation policy in Argentina is an extraordinarily obscure, difficult process, complicated even further when applied across multiple jurisdictions. Understanding the mechanisms that connect these policy disruptions with regional inequalities is needed first, especially through a spatial context.

Nevertheless, the results of this project suggest that inequalities in transit-facilitated accessibility exist vis-à-vis Buenos Aires' particular socio-territorial contexts and that there are problems needing to be addressed by the proper authorities. These findings could serve as the initiation of a larger study of accessibility across the entire region, serving as a feasible, relatively simplistic model for planners with limited resources. Ground studies to verify Google's travel times could be a good first step for policymakers from the departments—Quilmes, La Matanza, and Pilar—studied in this thesis. On a similar note, the INDEC could be directed to better incorporate *asentamientos* and *villas* into future censuses, whether including them as geographic units or directly surveying residents about living conditions and service provision. Given the relatively large proportion of people living in these precarious settlements, this could remove the uncertainty around their locations and provide a sense of official recognition. This would additionally shift the burden of surveying the *asentamientos* away from academics and NGOs, who are restrained in their investigative scope.

Regardless of which actions are taken, consideration must be given to the variation in accessibility within the conurbation. That different patterns exist relative to certain socioeconomic groups, transportation modes, land uses, and destination types suggests that any permanent solution in Buenos Aires must consider these variations. A solution for suburban Pilar will not inherently work in urban Quilmes. Furthermore, these findings also point to a need to consider both components of accessibility: transportation *and land use*. While not the focus of this thesis, land-use adjustments like relocating low-income housing to transit-accessible locations or constructing schools and health centers on well-situated parcels of land could be the ideal solution for improving accessibility in some municipalities, while fixing aspects of the travel system (i.e., adding a new stop, increasing frequencies, or building bus shelters) the best for another. What is most important is that the implementation process incorporates accessibility measures that have been thoroughly considered, and that the needs and demands of the *asentados*, with their unique locational and socio-economic characteristics, are fully represented.

Appendix A: Travel time maps, All case studies

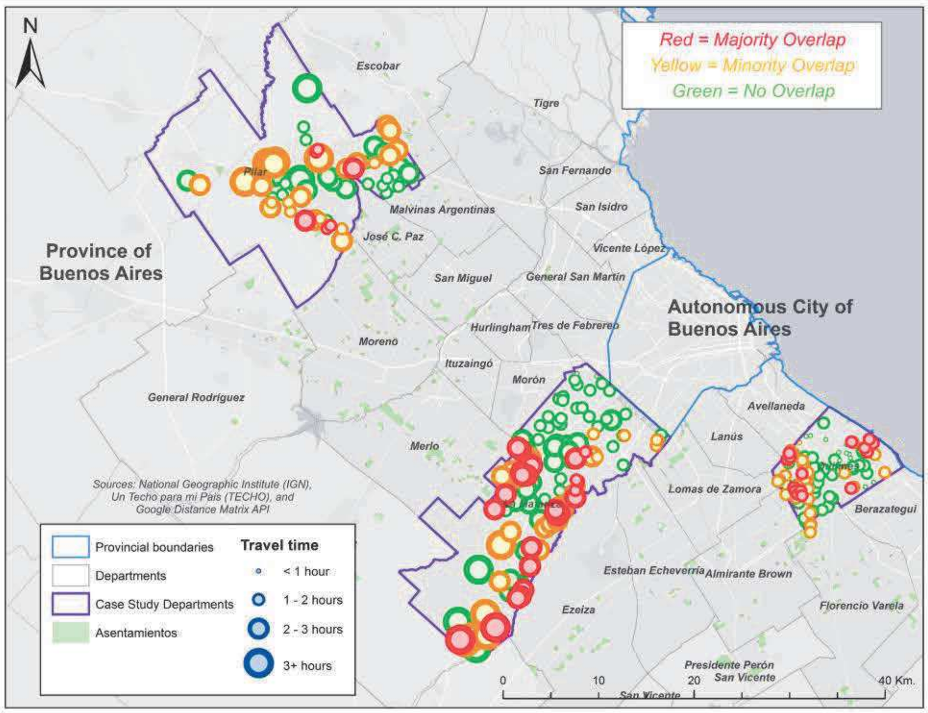


Figure A.1: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios to the central business district of the Autonomous City of Buenos Aires (CABA)

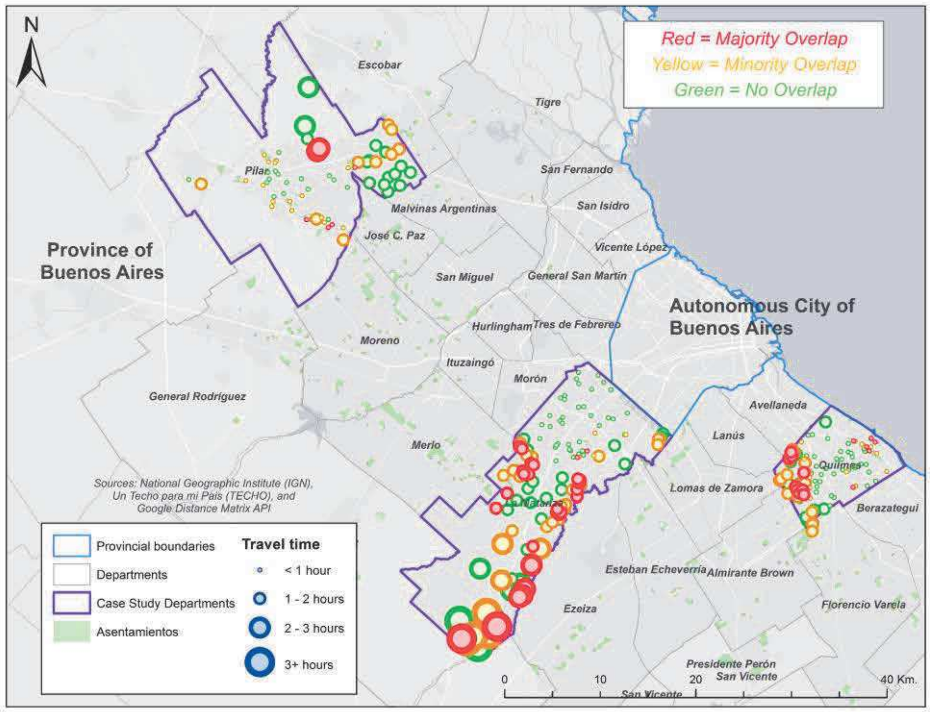


Figure A.2: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios to the central business districts of their respective departments

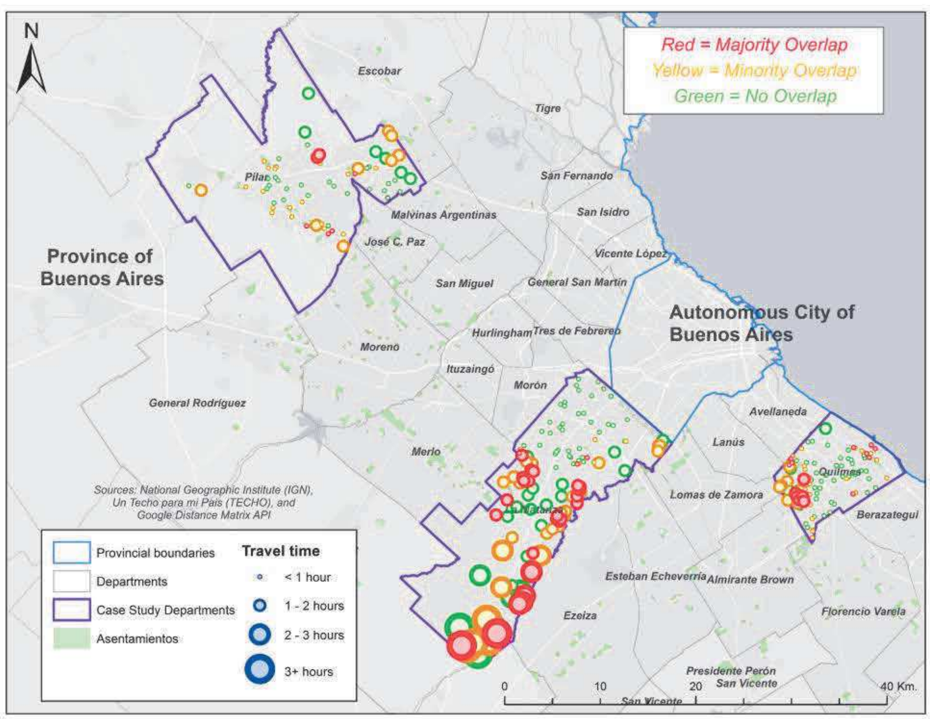


Figure A.3: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios to the nearest central business district of any department

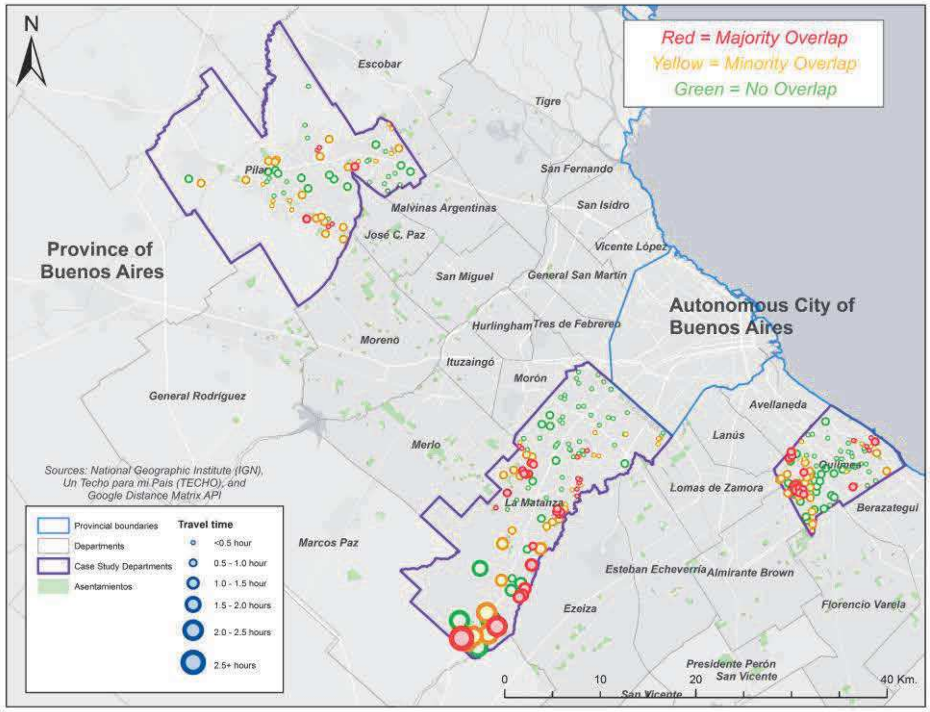


Figure A.4: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios to the nearest railway station

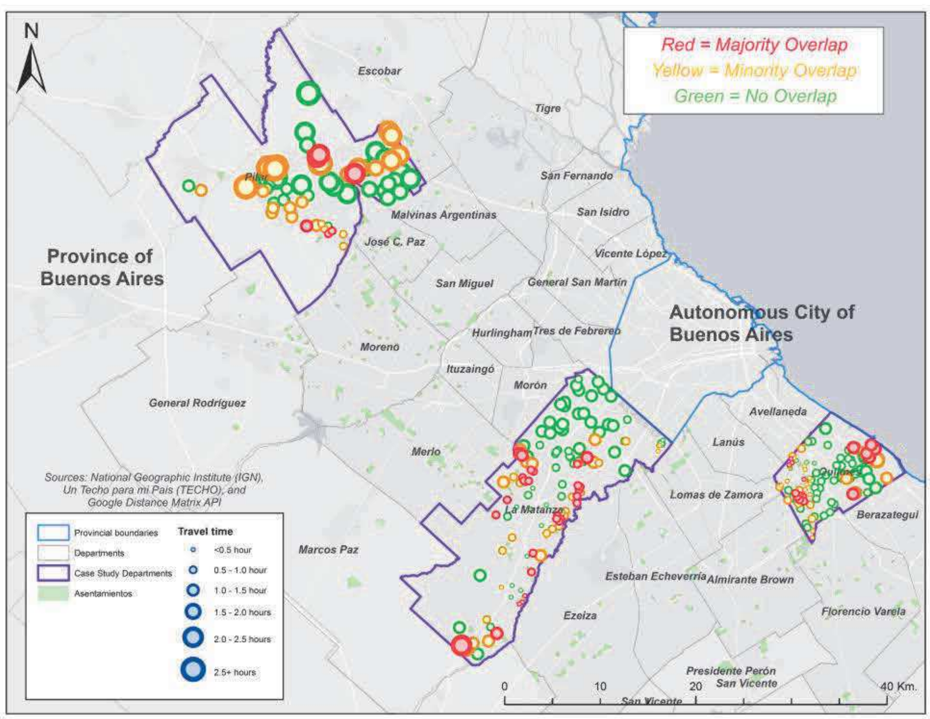


Figure A.5: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios to the nearest urgent care center (UPA)

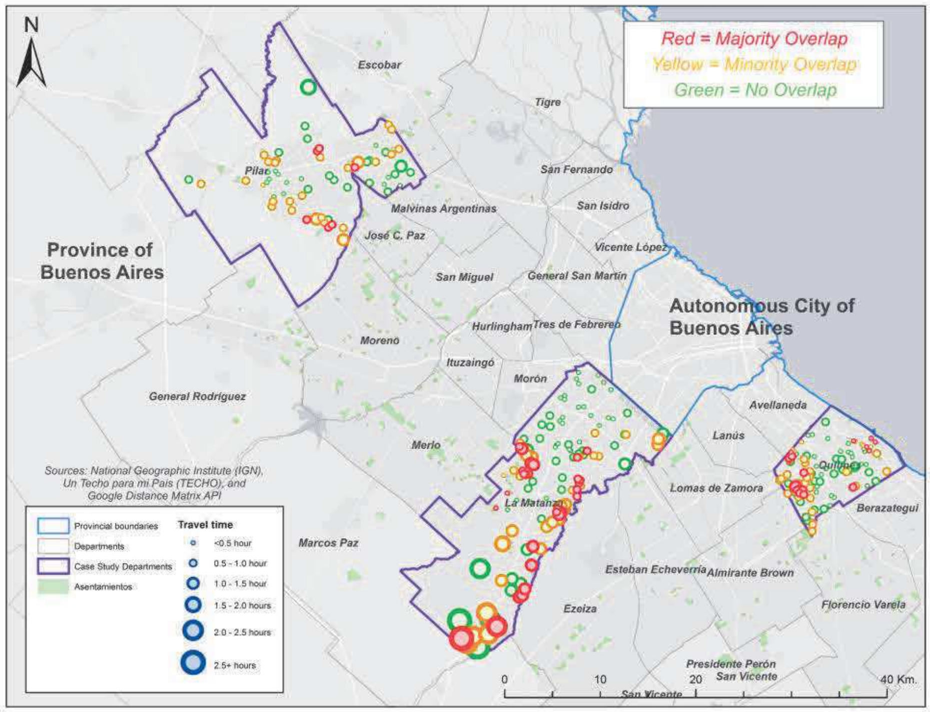


Figure A.6: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios to the nearest public hospital

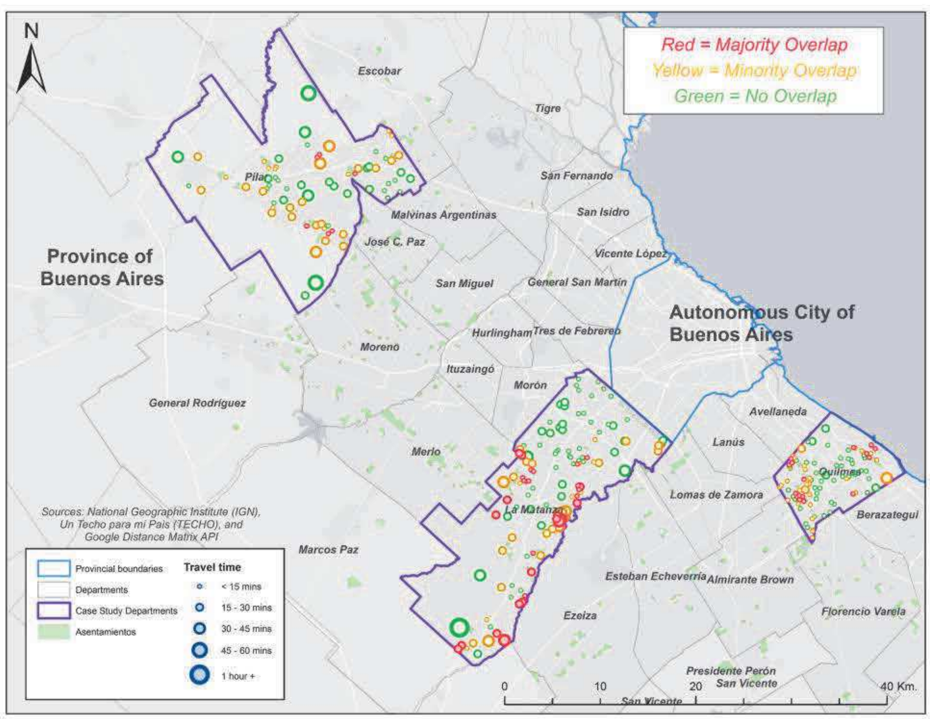


Figure A.7: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios to the nearest public diagnostic/treatment center

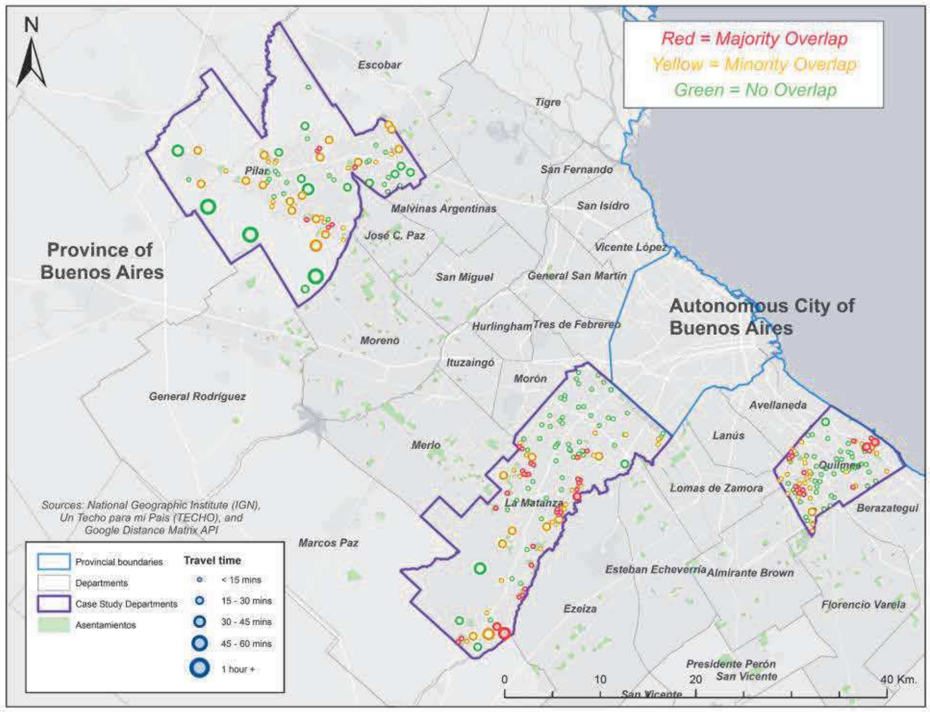


Figure A.8: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios to the nearest public kindergarten

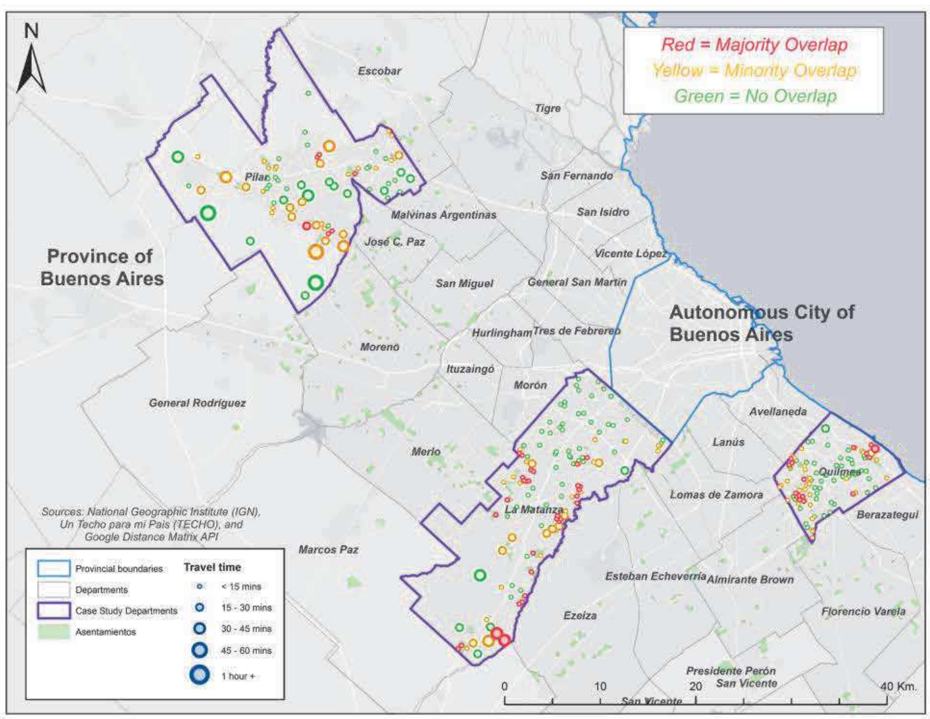


Figure A.9: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios to the nearest public primary school

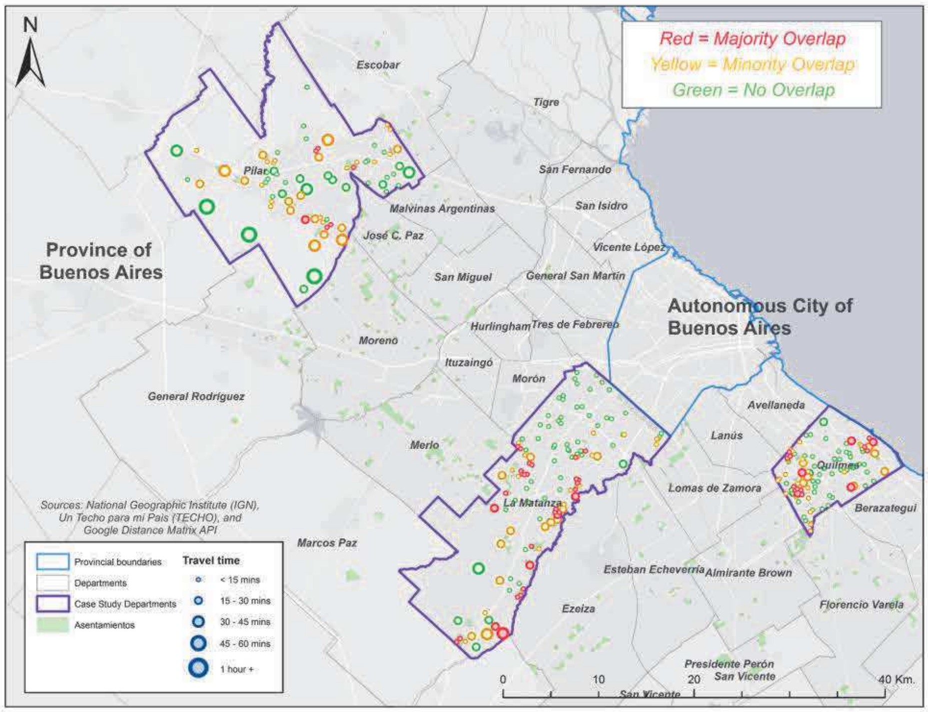


Figure A.10: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios to the nearest public secondary school

Appendix B: Travel time maps, Quilmes

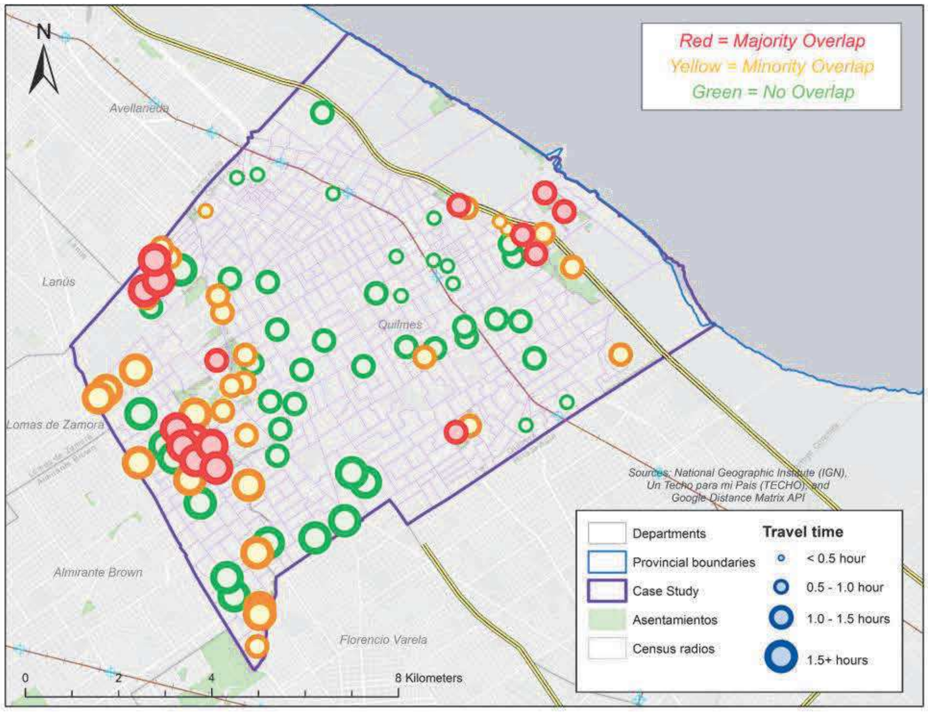


Figure B.1: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Quilmes to the central business district of the Autonomous City of Buenos Aires (CABA)

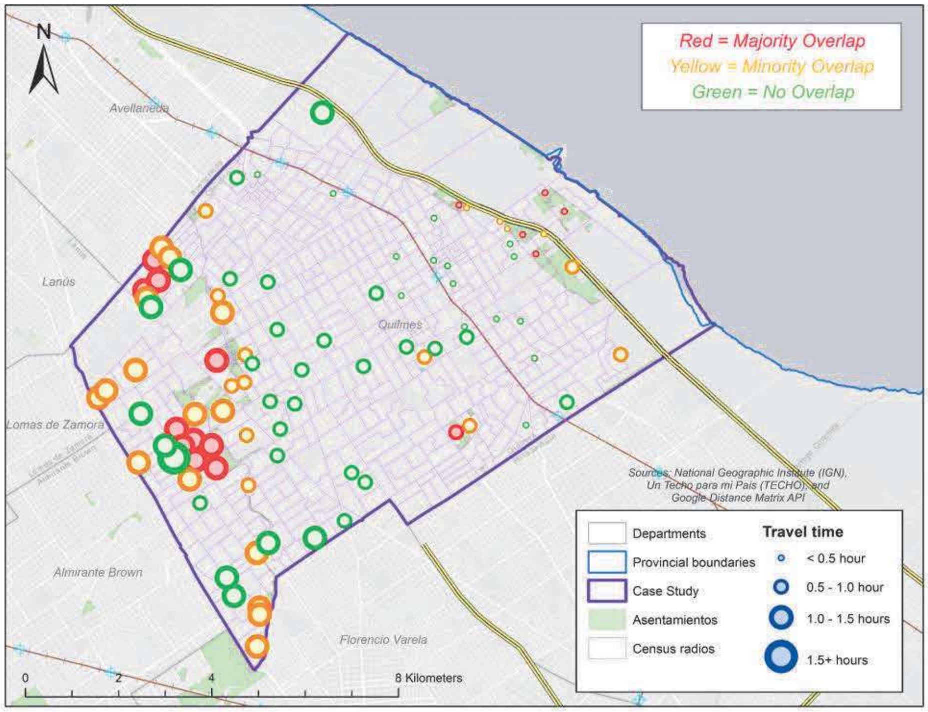


Figure B.2: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Quilmes to its central business district

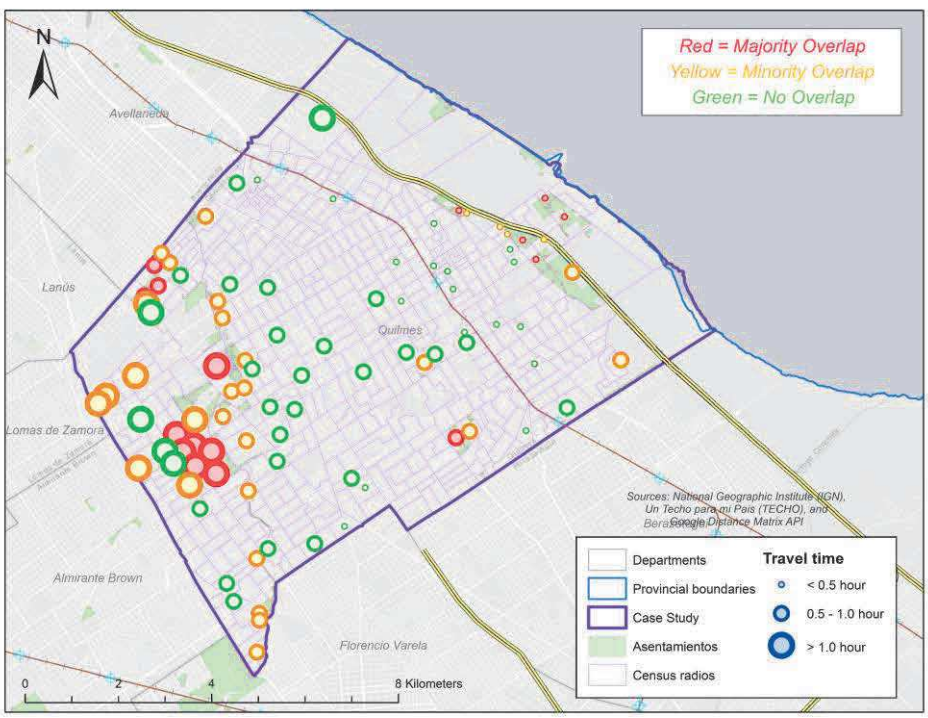


Figure B.3: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Quilmes to the nearest central business district of any department

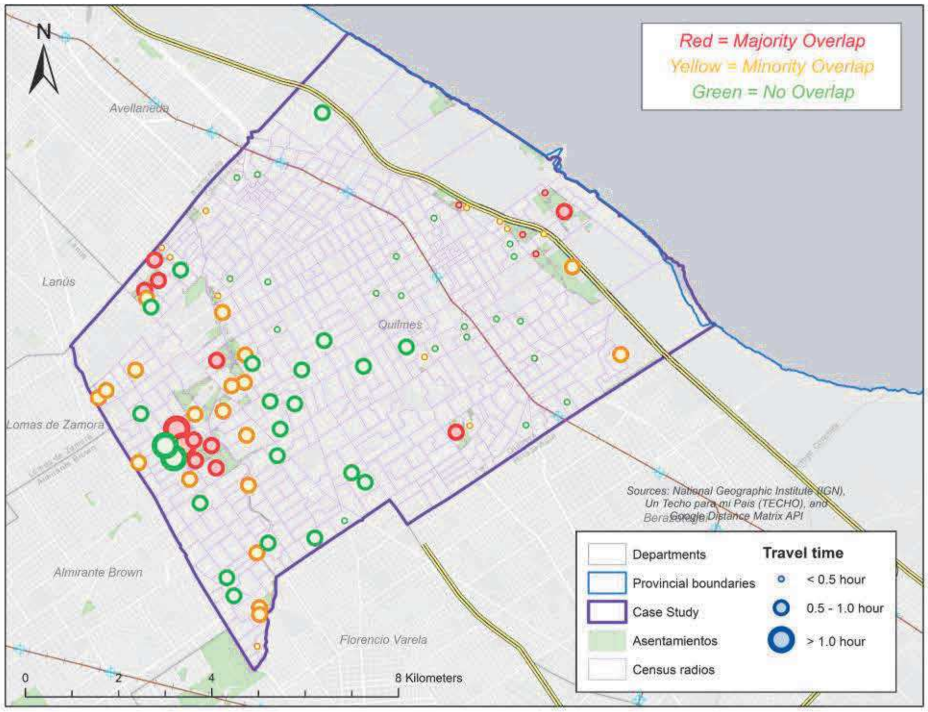


Figure B.4: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Quilmes to the nearest railway station

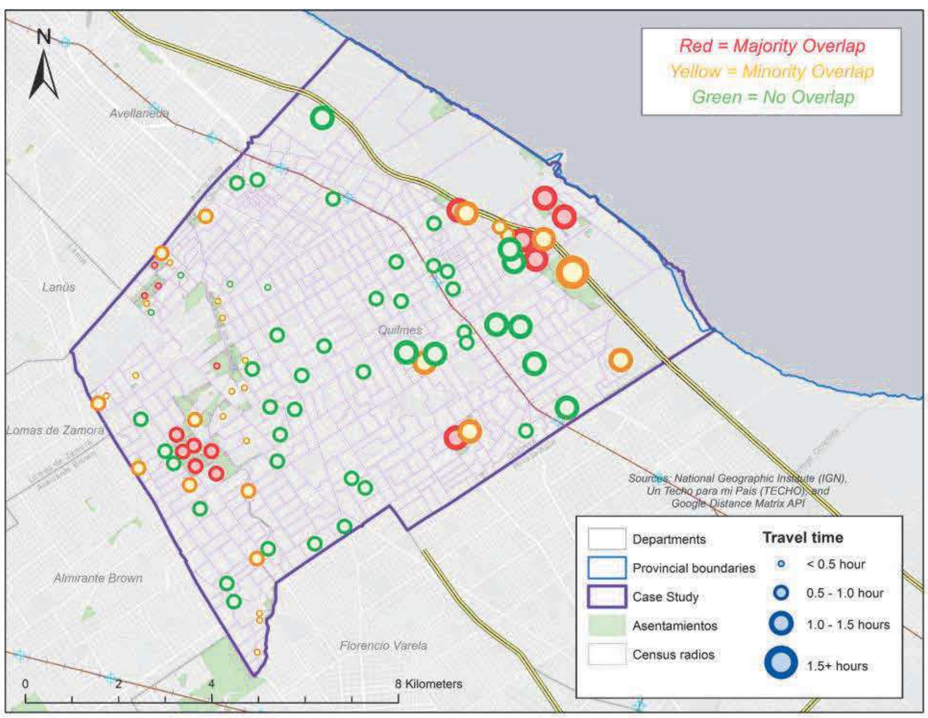


Figure B.5: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in Quilmes to the nearest urgent care center (UPA)

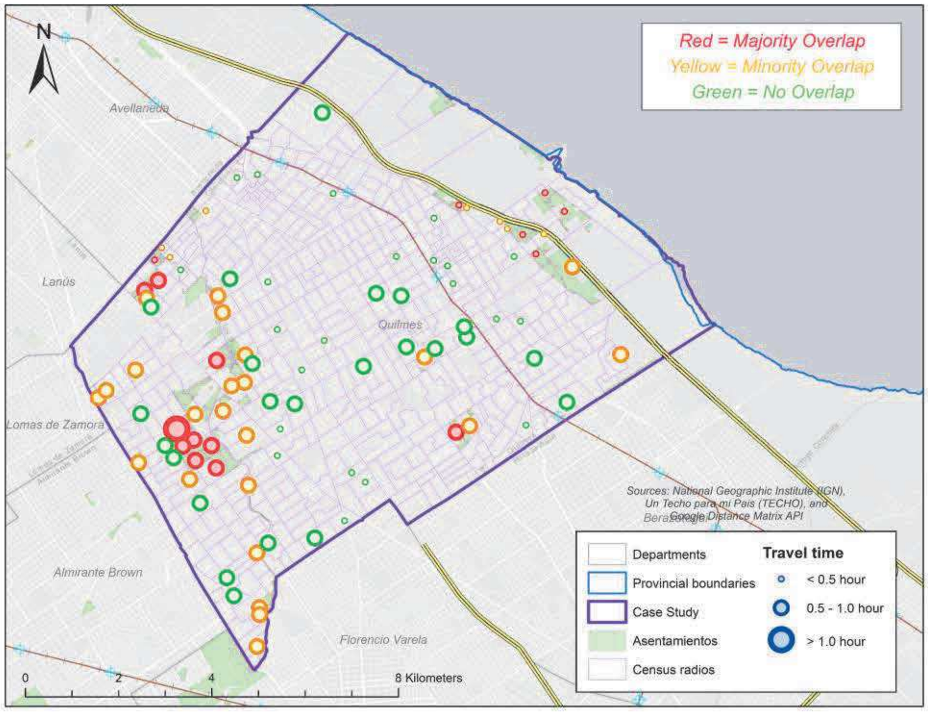


Figure B.6: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in Quilmes to the nearest public hospital

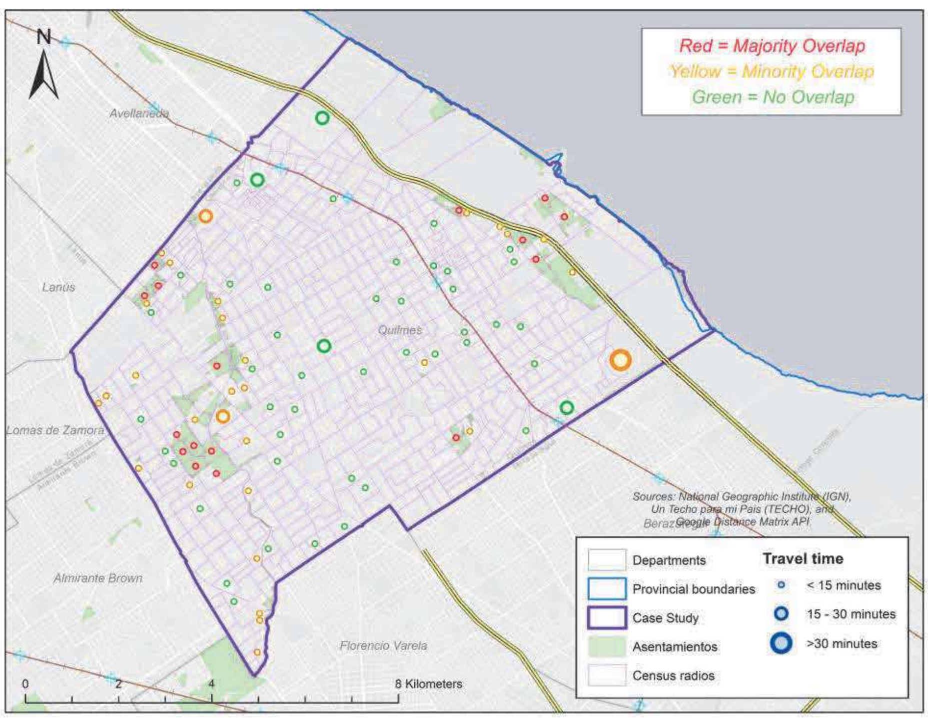


Figure B.7: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in Quilmes to the nearest public diagnostic/treatment center

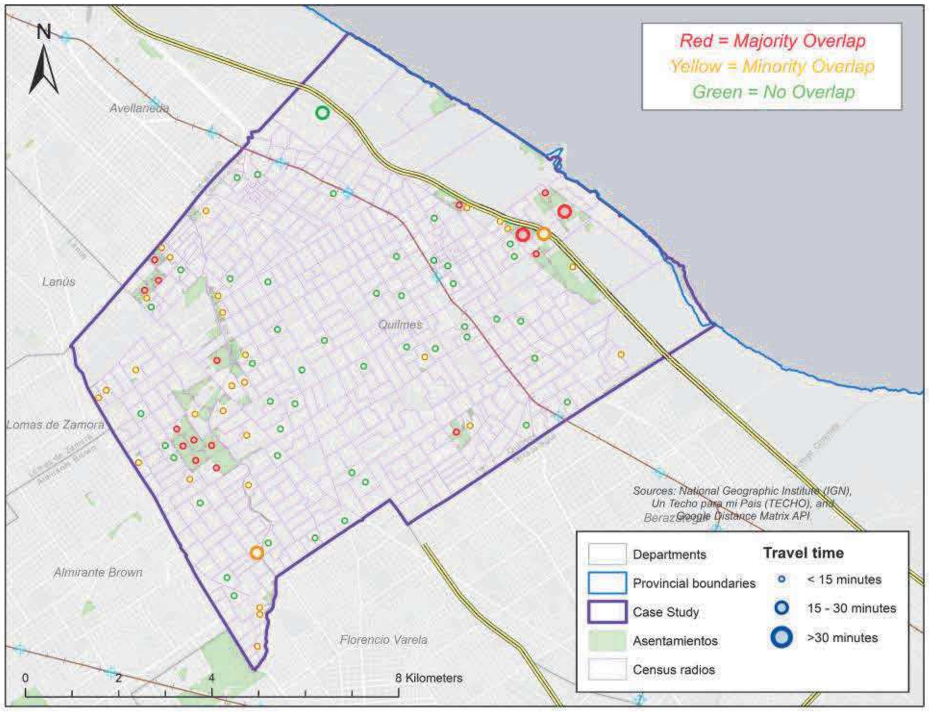


Figure B.8: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in Quilmes to the nearest public kindergarten

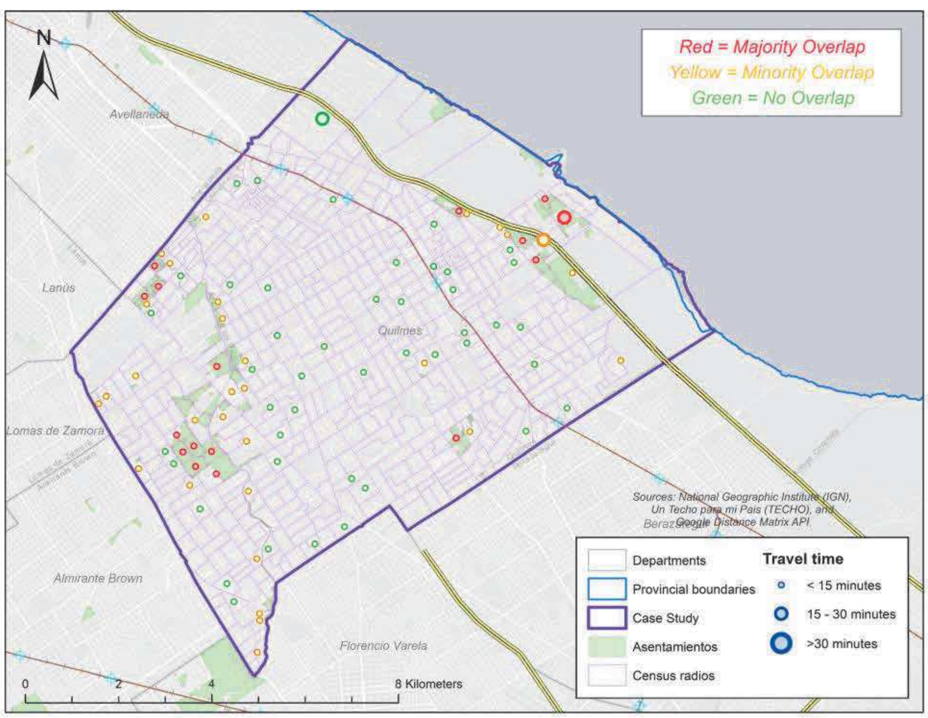


Figure B.9: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in Quilmes to the nearest public primary school

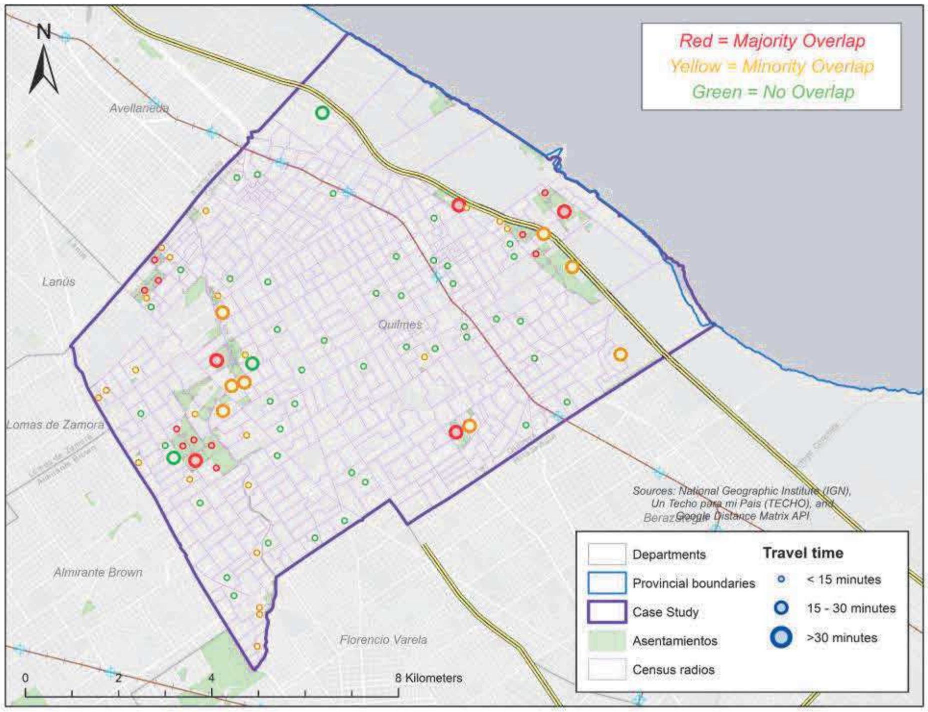


Figure B.10: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in Quilmes to the nearest public secondary school

Appendix C: Travel time maps, La Matanza

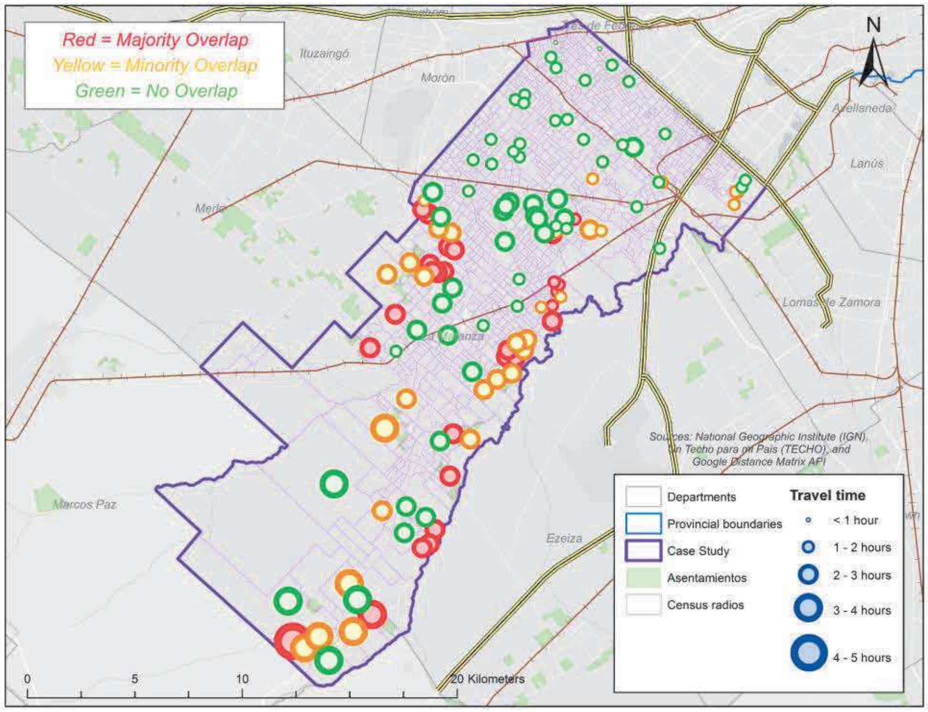


Figure C.1: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in La Matanza to the central business district of the Autonomous City of Buenos Aires (CABA)

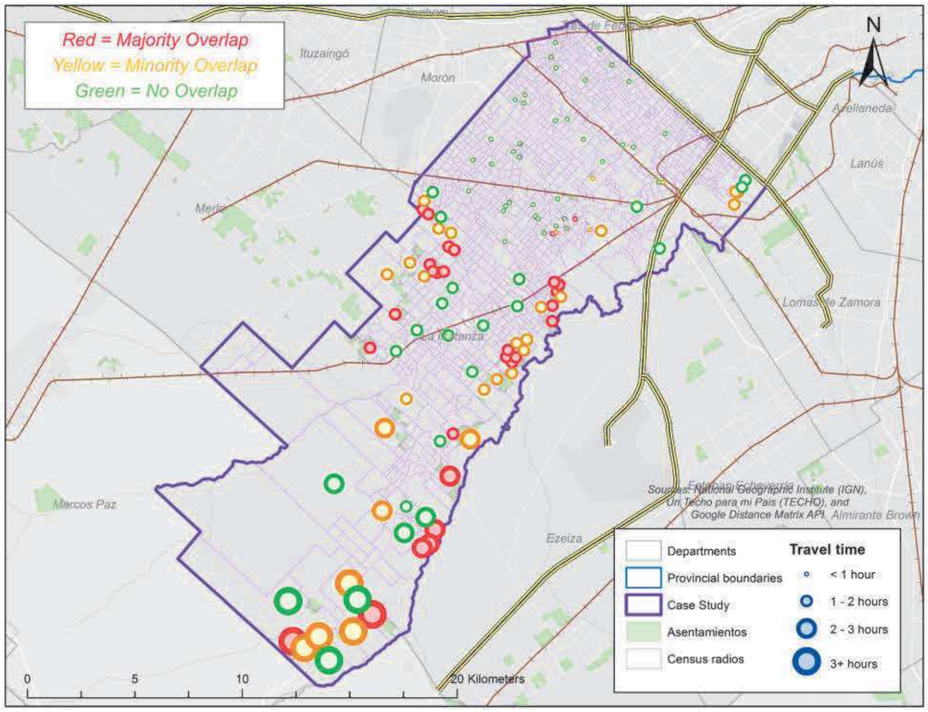


Figure C.2: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in La Matanza to its central business district

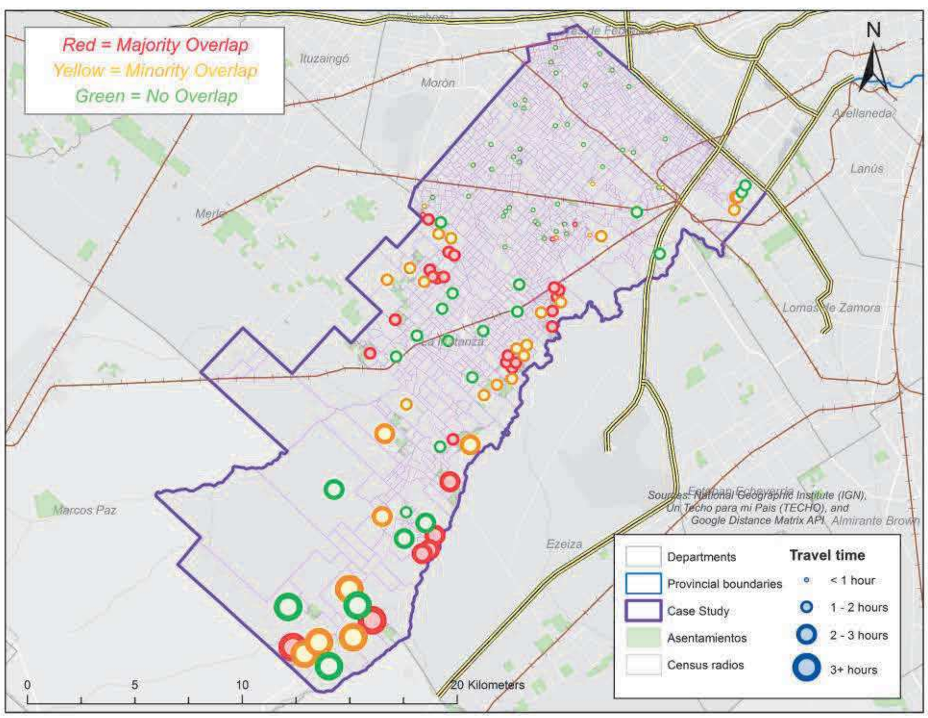


Figure C.3: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in La Matanza to the nearest central business district of any department

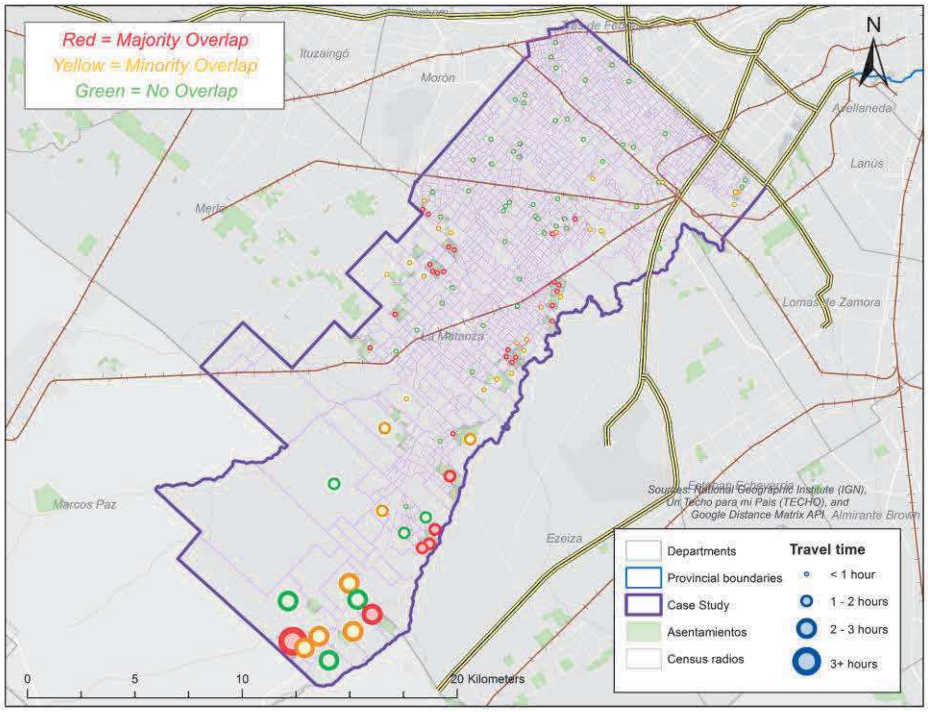


Figure C.4: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in La Matanza to the nearest railway station

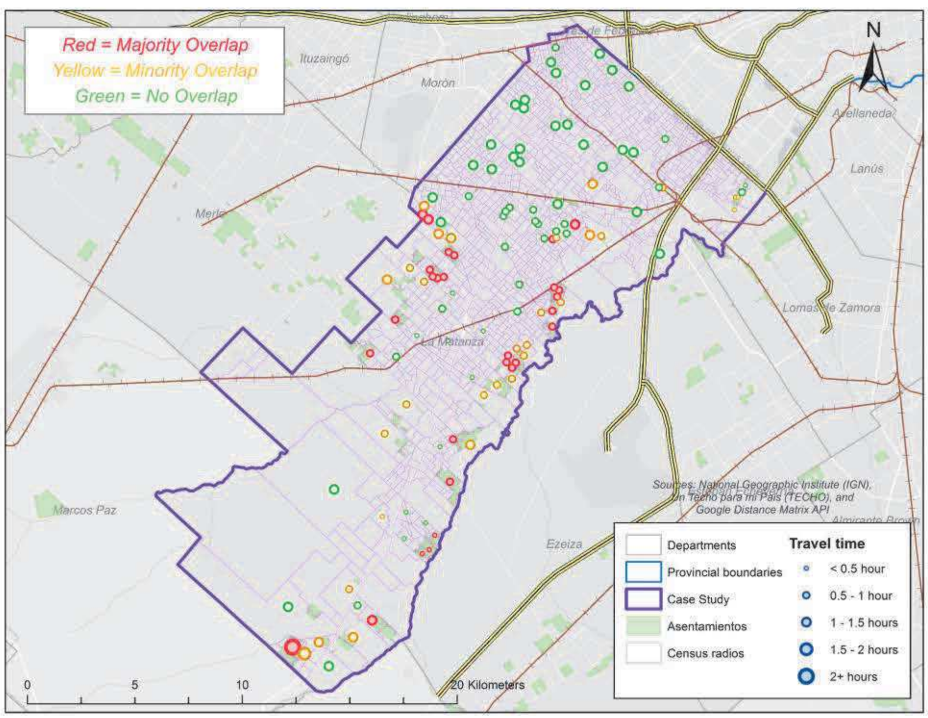


Figure C.5: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in La Matanza to the nearest urgent care center (UPA)

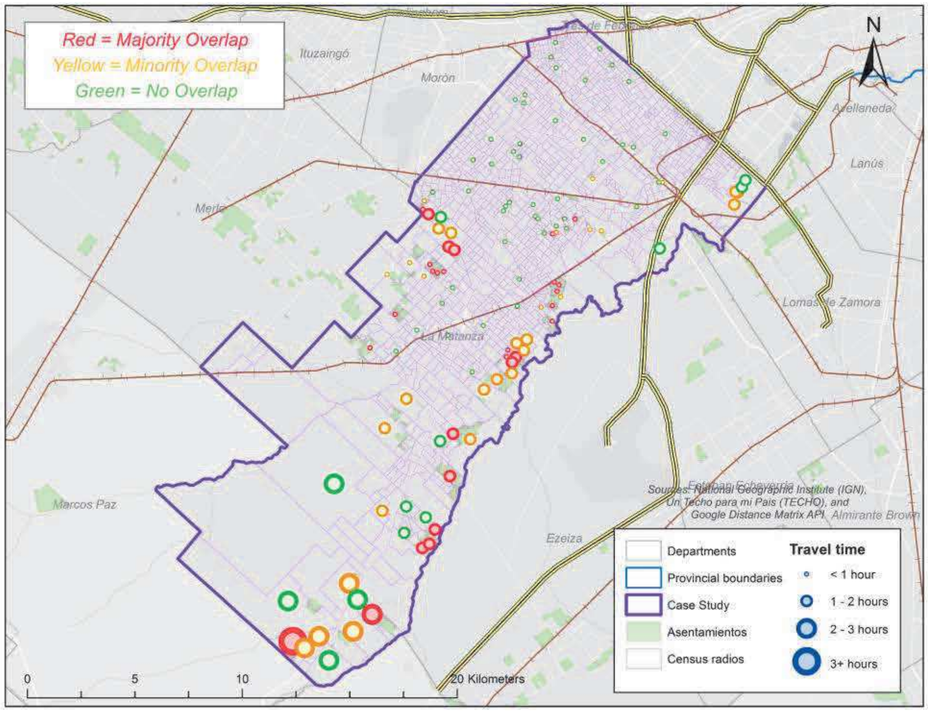


Figure C.6: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in La Matanza to the nearest public hospital

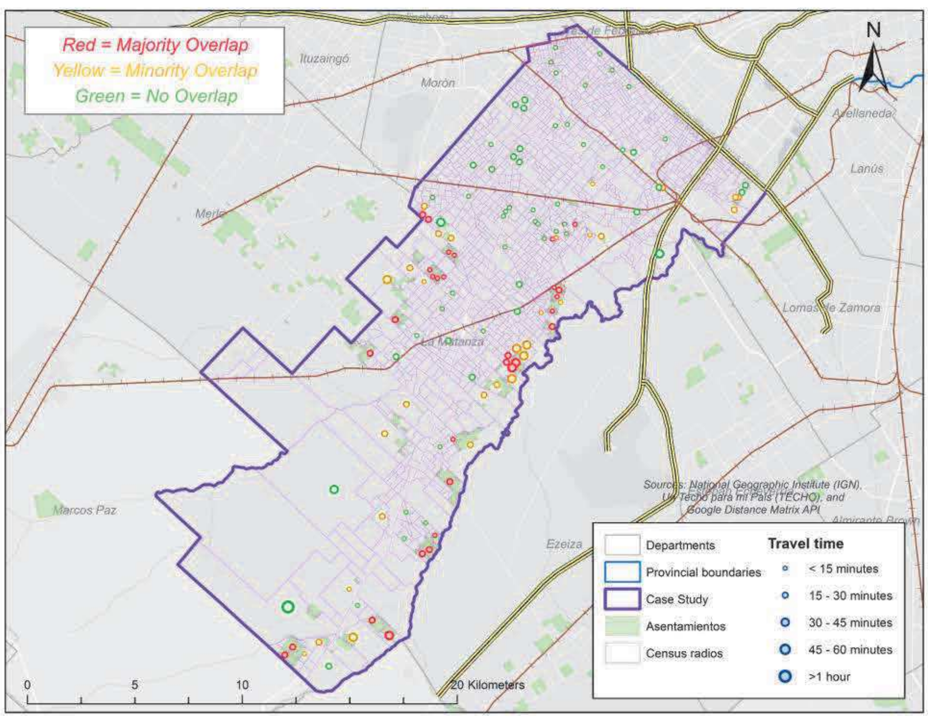


Figure C.7: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in La Matanza to the nearest public diagnostic/treatment center

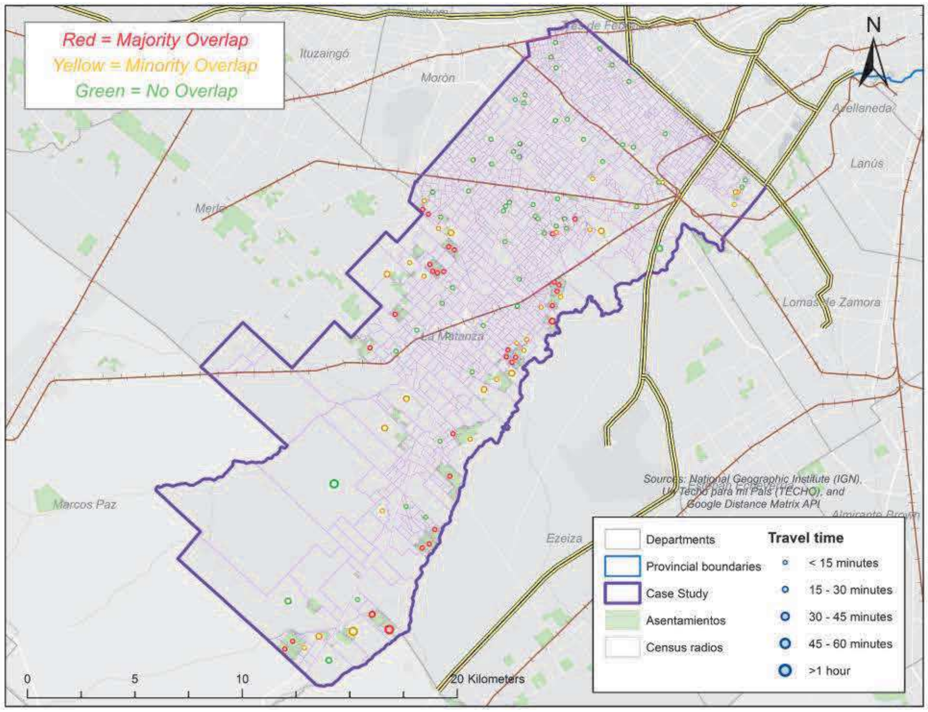


Figure C.8: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in La Matanza to the nearest public kindergarten

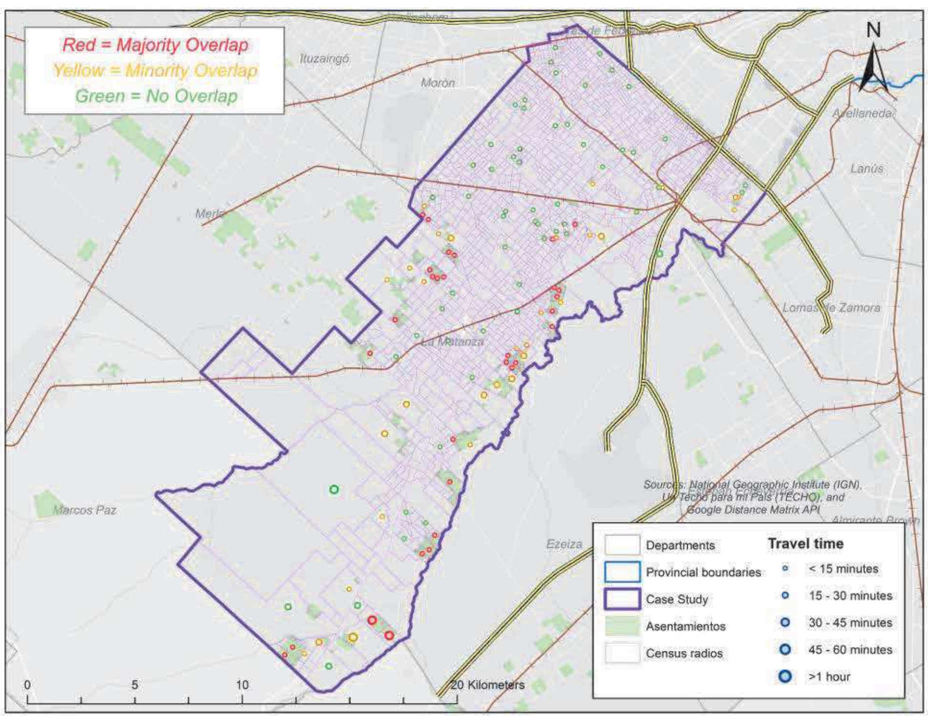


Figure C.9: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in La Matanza to the nearest public primary school

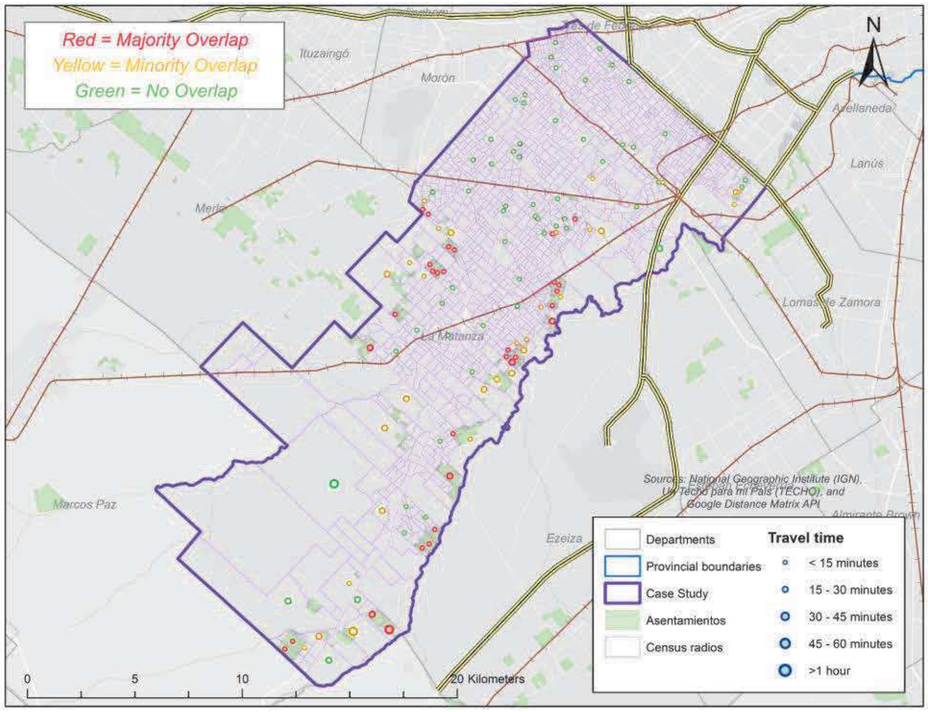


Figure C.10: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in La Matanza to the nearest public secondary school

Appendix D: Travel time maps, Pilar

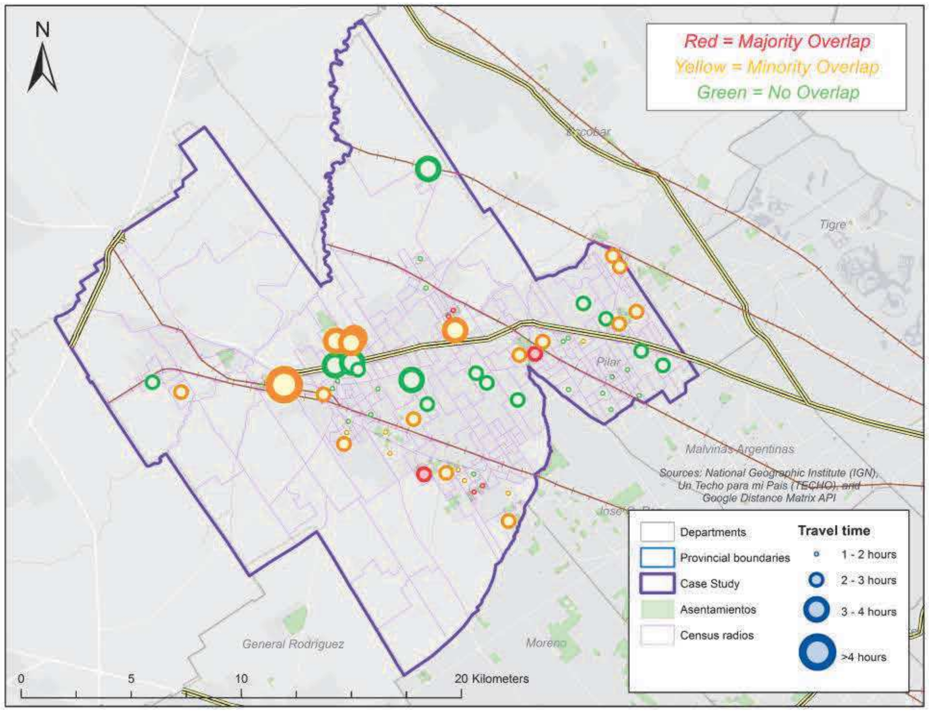


Figure D.1: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Pilar to the central business district of the Autonomous City of Buenos Aires (CABA)

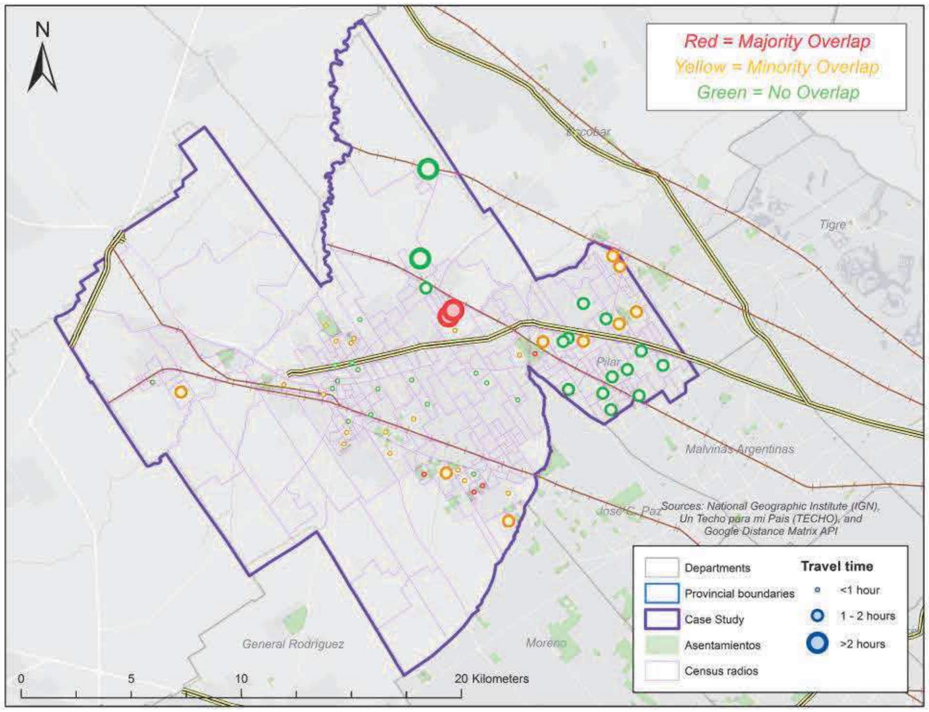


Figure D.2: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Pilar to its central business district

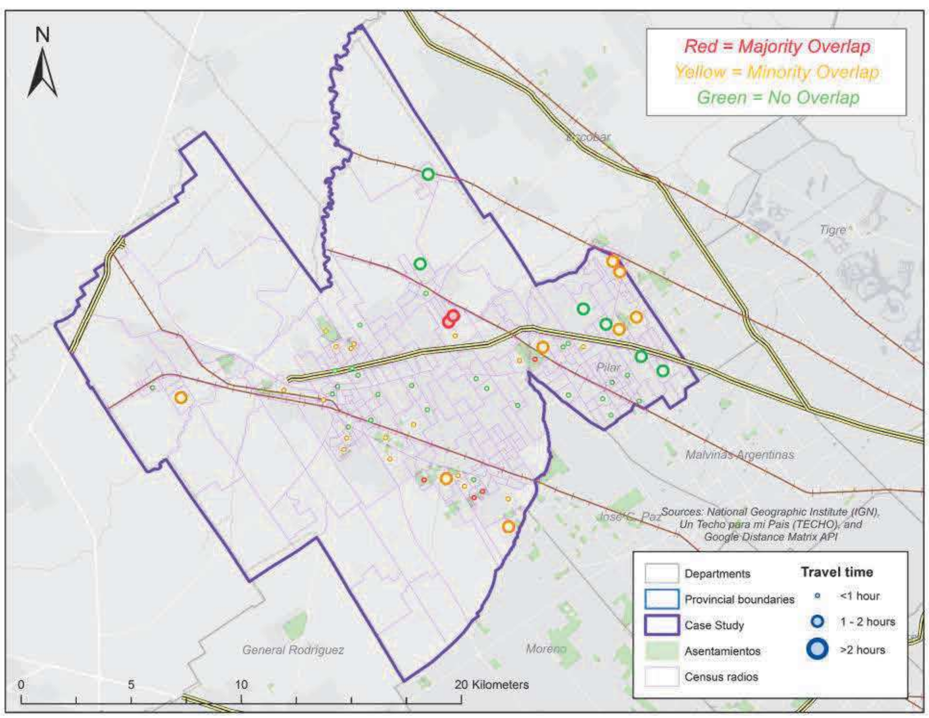


Figure D.3: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Pilar to the nearest central business district of any department

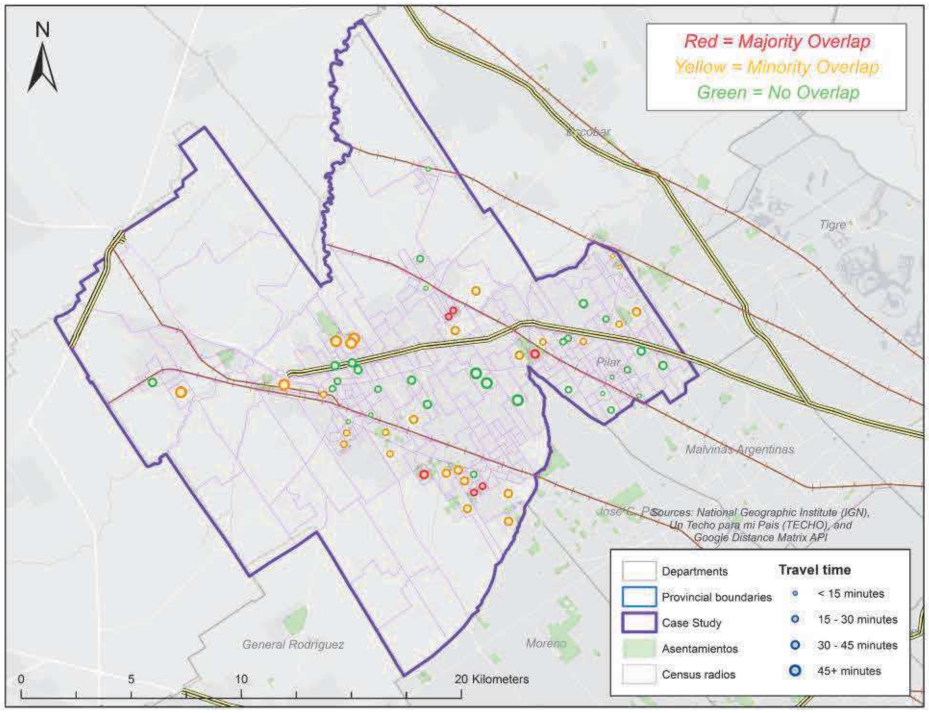


Figure D.4: Travel times on public transportation (at 7:00am on a Wednesday) from all sampled census radios in Pilar to the nearest railway station

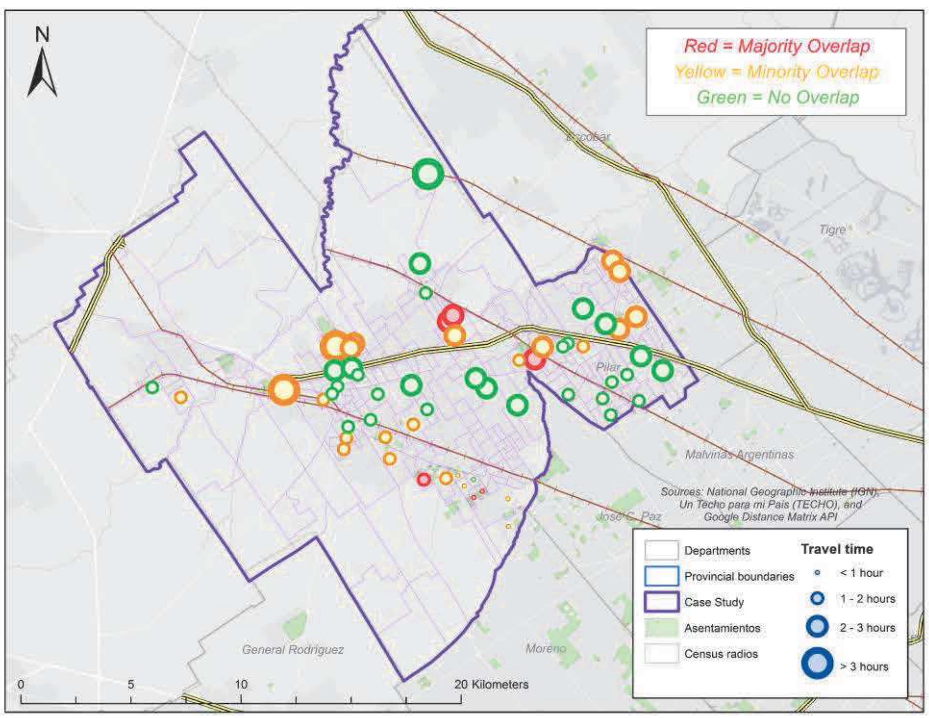


Figure D.5: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in Pilar to the nearest urgent care center (UPA)

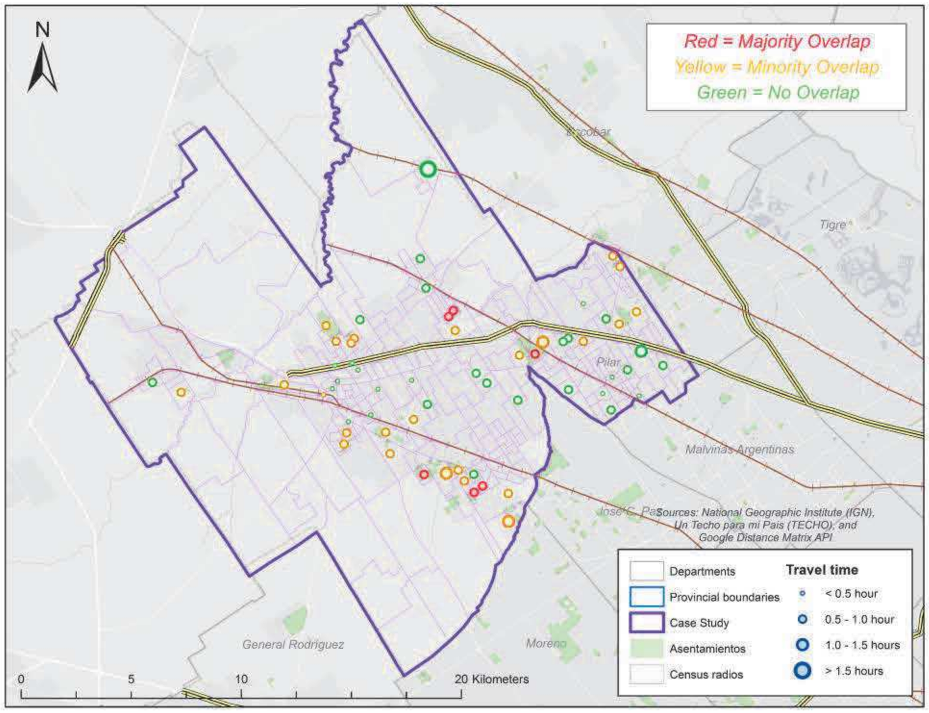


Figure D.6: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in Pilar to the nearest public hospital

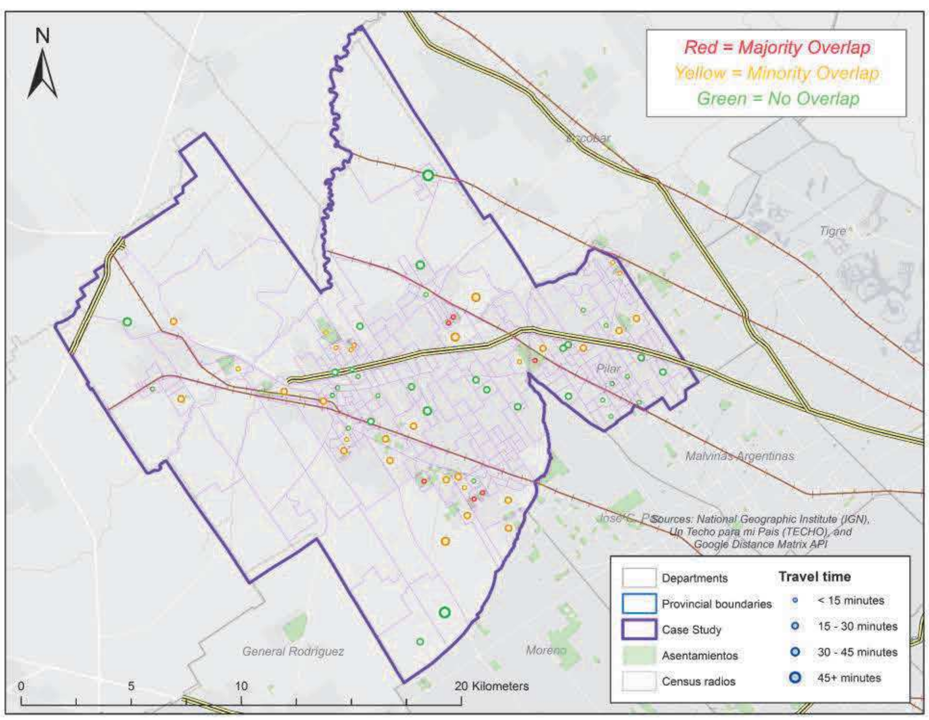


Figure D.7: Travel times on public transportation (at 10:30am on a Wednesday) from all sampled census radios in Pilar to the nearest public diagnostic/treatment center

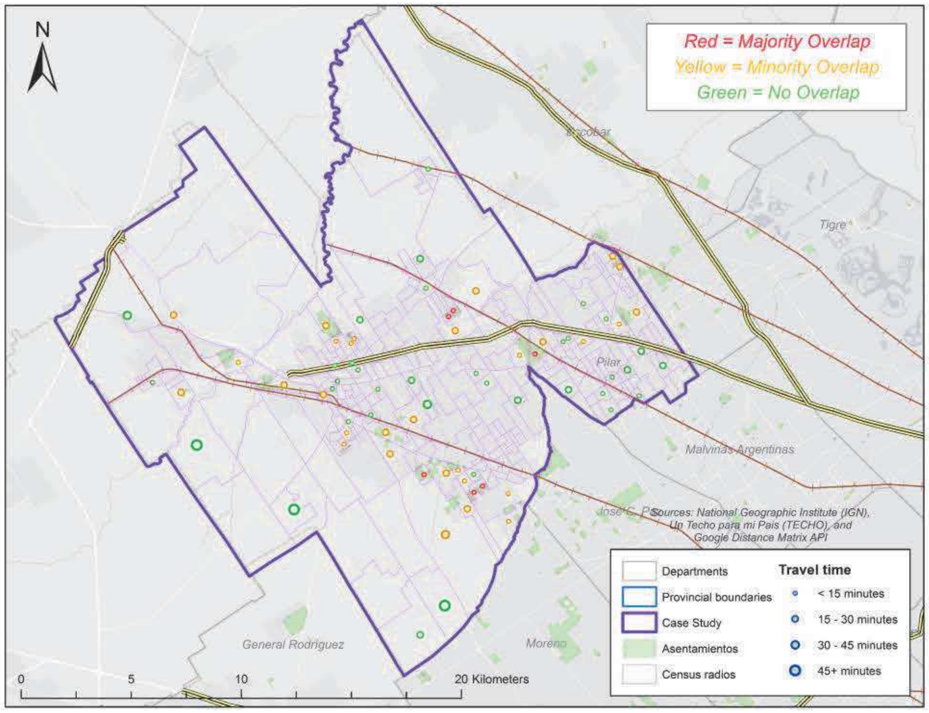


Figure D.8: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in Pilar to the nearest public kindergarten

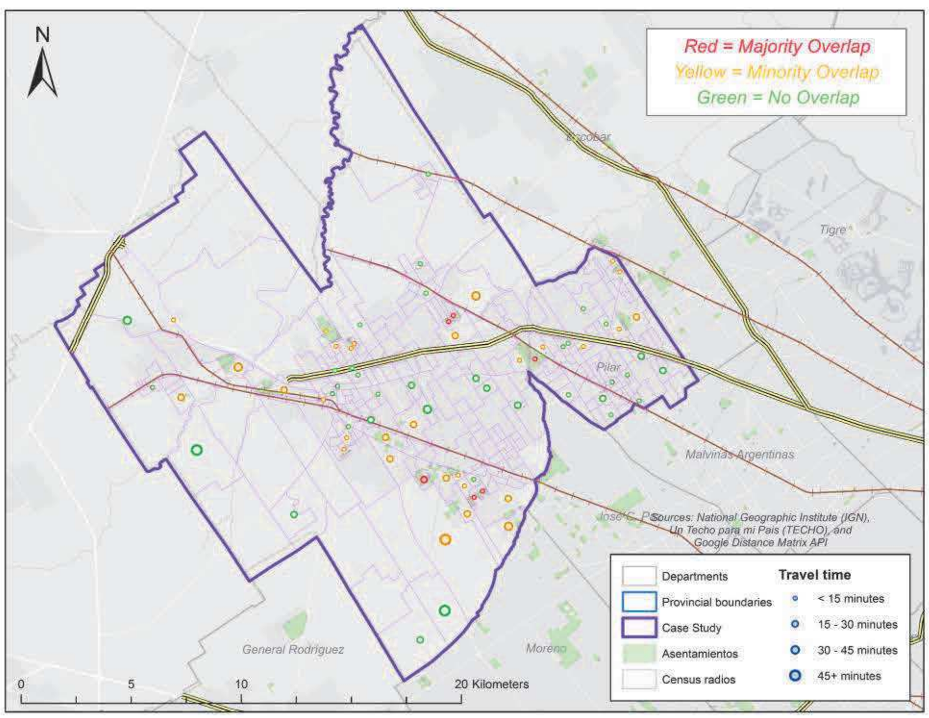


Figure D.9: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in Pilar to the nearest public primary school

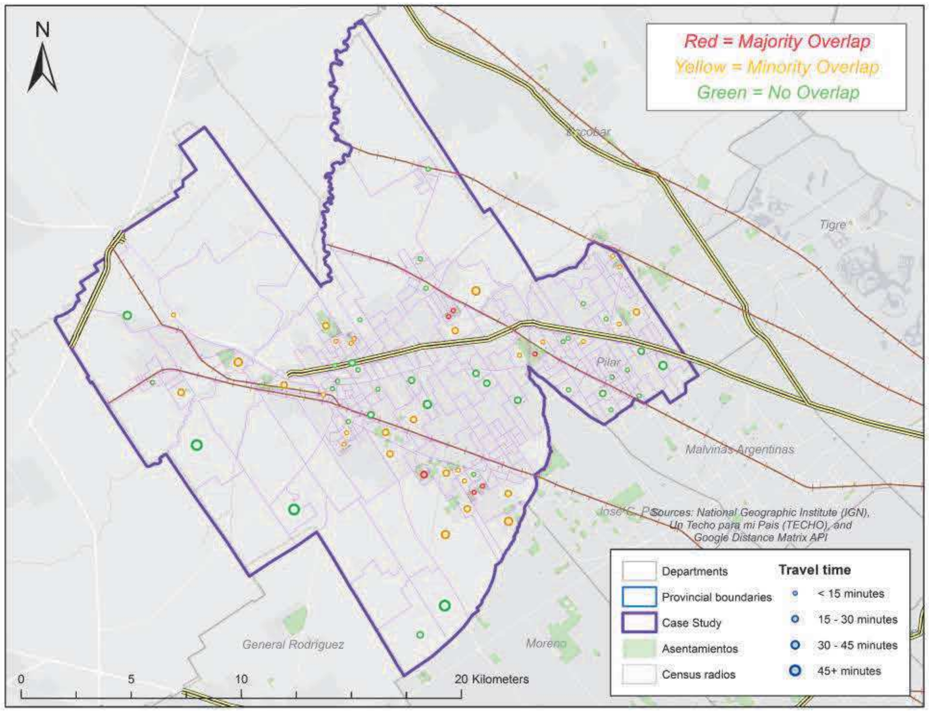


Figure D.10: Travel times on public transportation (at 12:00pm on a Wednesday) from all sampled census radios in Pilar to the nearest public secondary school

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