REACHING LIVABILITY: DESIGNING ACCESSIBLE CITIES FOR ALL

by

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Abstract

While sustainability dominates the discourse in urban theory and practice, a growing literature has recognized the importance of liveability in city-making. Livability is the sum of factors that contribute to a city's quality of life. One significant factor is access to services and goods for pedestrians, an aspect of planning that scholars and planners have long neglected. Accessible amenities fulfil a city's function and are an essential component of 'good urban form': a material and ethical morphology of the city that privileges compactness and mixed land uses to integrate amenities and people. Cities around the world, especially those in North America, face challenges that stem from sprawling urban forms. As a result, constrains to access for the pedestrian abound. Importantly, this phenomenon exists beyond global and globalizing cities. Indeed, while the literature focuses on larger cities, there is an increasing need to explore and understand the fate of medium and smaller cities. This study contributes to the small city scholarship by offering a descriptive assessment of access to amenities in a mid-size Canadian city, St. John's (NL), through an analysis of census and business microdata between 2006 and 2010. I argue that given St. John's urban form (low-density, disconnected streets, low mix use, car-friendly), access to amenities is low across the metropolitan region. My findings have several significant results: first, the average minimum distances to amenities exceed the established walking standard of 500m across the St. John's metropolitan area; second, there is a mismatch of population to amenity across the region; third, vulnerable demographic groups like the young and the elderly who are in higher need of amenities typically enjoy better access than others; and fourth,

accessibility is better where urban form is more compact. Finally, I conclude that accessibility in St. John's is spatially unequal, but fairly equitable, and that areas with higher accessibility are concentrated in old City of St. John's.

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List of Abbreviations

CBS – Conception Bay South

CCI – Coverage criterion I

CCII – Coverage criterion II

CCIII – Coverage criterion III

CMA – Census metropolitan area

DA(s) – Dissemination area(s)

NIP – Neighbourhood Improvement Program

QOL – Quality of life

SJCMA – St. John's census metropolitan area

WAL1A – With at least 1 amenity

WOAs – Without amenities

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Chapter 1 : Introduction

1.1 Living, working, and playing for all in St. John's: Is it possible?

> The Churchill Park development represented the start of the suburbanization of St. John's (Shrimpton & Sharpe, 1980, p. 93).

> [Churchill Park] introduced "modern" house and neighbourhood design intro the country, offering to its inhabitants a residential environment radically different from anything seen previously. The development doubled the area of the City, and its long-term impacts on the development of St. John's can hardly be underestimated (Sharpe, 2006, p. 1719).

> I almost expect to see tumbleweeds roll past my feet when I walk along a stretch of Rowan Street in Churchill Square these days. That would be the site of the SaveEasy grocery store, which shut down this winter, the last of a series of grocery stores to have been on the location for more than 50 years (Gushue, 2012, p.1).

These epigraphs represent three distinct periods in the urban history of St. John's, the capital city of Newfoundland and Labrador. From the creation of Churchill Park – one of the first and largest garden suburbs in North America – to the suburbanization that followed, and the current state of decline of the city's central commercial landscape, these three passages highlight a city in change. First developed as a compact community with a vibrant downtown area, St. John's has since become a sprawling city, characterized by low density, single-use neighbourhoods and big box retail (Collins, 2004; Shrimpton & Sharpe, 1980; Forward, 1957). Following the construction and development of Churchill Park in the 1940s, which effectively doubled the size of old St. John's, the local housing stock increased substantially, alleviating the crowding and poor sanitation of the inner-city. All planning decisions have impacts, however, and the choice to sprawl has since led to a lack of interest to build for density, mixed land use, and to sustain local farmland. The actions of the past have set the stage for further

suburbanization and expansion through the St. John's metropolitan region (Shrimpton & Sharpe, 1980).

According to geographer Christopher Sharpe (2006), the developers of Churchill Park had a clear vision in the 1940s: to offer residents a 'cleaner' and 'closer-to-nature' environment that meets the changing needs and conveniences of modern urban life. By all intents and purposes, Churchill Park was the first attempt in the province to build the 'garden suburb', a utopian model of (sub)urban development that reached world-wide attention by the early twentieth century (Ward, 2005). For their part, urban planners in St. John's envisioned three villages of "single family houses and flats…planned around neat shopping centres", a landmark site that enabled communities to live, work and play (Bland, 1946, p. 6). However, that vision was short-lived. Only 'Village A' – one of three live/work/play areas planned for the suburb – was built, with Churchill Square as its shopping area. With only one commercial area, Churchill Park fell short of providing accessible amenities to its residents. The replication of the garden suburb across the city led to a process of suburbanization, spatial expansion, and the loss of accessibility for pedestrians of all backgrounds (Shrimpton & Sharpe, 1980).

Beyond the local scale, however, Churchill Park is part of the national story of suburban development and transformation of urban Canada. Over the last decades, municipal governments have conceded power to private interests, supported by a growing consumer market and NYMBYist culture (Grant, 2001). At first, Churchill Park was a project to be lauded: as a public good, the park was a direct attempt to maintain local control of development and build self-contained communities with access to green space.

In time, however, the project proved too expensive for the government and, in the resulting privatization of development, only one live/work/play community was built (Sharpe, 2005). Elsewhere in the city, this trend continued.

As a direct result of this urban transformation from compactness to sprawl, people who do not own a private vehicle have suffered the most. In fact, an important literature on pedestrianzation is emerging and growing, as a response to the neglect of people on foot that have made cities inhospitable to the non-driver. Pedestrianization is an integral part of the discussion in my thesis and I made use of the urban geography literature to address the research on pedestrians. In addition, pedestrians' behavior has been studied in relation to urban form and design (Jin, 2012), which is further evidence of the interconnection between pedestrians and other urban issues.

Spurred by the demands of car owners, city councils increasingly segregated land use and greenlighted strip malls and 'big box' retailers spearheaded by profit-seeking developers (Simmons & Hernandez, 2006). These developments pulled people and businesses away from the downtown area (Shrimpton & Sharpe, 1980), leading to a dispersion of activity into commercial islands that are hard to access on foot. By 2012, this commercial decline spread to Churchill Park. As the third epigraph above describes, Village A (Churchill Square) had lost its last and only grocery store; a process that was replicated over time (CBC News, 2015). Geographers and other researchers interested in the urban environment have long argued that such trends consistently result in negative impacts for all types of communities and their quality of life (Witten *et al.* 2003; Talen, 2002b; Smith *et al.*, 1997). When amenities disappear, neighbourhoods lose their vitality

and accessibility. One key result is that *particular* people suffer. Indeed, citizens that are less mobile, such as university students and senior citizens in Churchill Park, are disproportionately affected by the cultures of land-use and planning that cater to decentralization and reduced access.

In addition to the loss of centralized and traditional commercial activity, single detached housing continues to be the residential style of choice in St. John's. Part and parcel of this trend is the fact that eighty percent of St. John's' residents drive, while the street networks have low connectivity and are characterized by car-friendly developments like cul-de-sacs (Statistics Canada, 2010b; 2008). In short, St. John's urban form has become non-compact, with decreasing densities despite steady population growth (Statistics Canada, 2008). However, while the changing urban form may enhance our understanding of change in urban function, it does not always provide a complete picture. After all, Churchill Square continues to have mixed land use and the SaveEasy store is still owned by its parent company, Loblaw and Co. In addition, demand for a grocery store in the area remains strong (Gushue, 2012). Despite retaining its urban form, accessibility has decreased. This may be due to the pull factors caused by the dispersion of commercial activity elsewhere, but it could also be a result of other forces at play. Nevertheless, I argue that it is imperative to first question urban function. With this in mind I ask: Is the city providing for its residents? Are amenities accessible to all?

While we might single out Churchill Park, these central questions warrant a wider investigation beyond this local community to understand just how accessible amenities are for citizens across the St. John's metropolitan area.

1.2. Research questions and objectives

The primary goal of this thesis is to evaluate the landscape of accessibility in St. John's. In particular, I explore pedestrian accessibility to various amenities across all neighbourhoods in the St. John's Census Metropolitan Area (CMA) in 2010. The second objective is to understand what drives different levels of accessibility by evaluating the City's distinct urban form. More specifically, this thesis attempts to answer the following questions:

1. How accessible is the St. John's CMA for people on foot in terms of their ability to reach amenities?
2. Are there differences in accessibility across parts of the metropolitan area?
3. Is accessibility higher where there is more population or is there a mismatch of population to amenities?
4. Are there differences in accessibility by amenity? If so, which amenities are more accessible?
5. Are there differences in accessibility by demographic group? If so, which segments of the population have higher and lower accessibility?
6. Is there a relationship between urban form and accessibility?

The analysis first requires an analysis of accessibility. By drawing from a detailed and well-established methodological literature, a number of measurements are conducted. To begin, facilities and services are counted across the CMA and by census dissemination area. Second, distances are measured to determine the average time it takes a pedestrian to access amenities. In addition, an analysis of amenities per number of people is undertaken to assess whether accessibility is higher where need is higher. Finally, urban form is analyzed to determine whether a less compact form affects accessibility. This is accomplished by comparing accessibility measures in the denser and more compact downtown areas of St. John's with the more dispersed areas farther from the harbour.

Urban form is measured through a comparison of pre-war urban St. John's and post-war urban St. John's, according to levels of population and building density, land-use mix, and distance to amenities.

1.3. Thesis structure

This thesis is divided into seven chapters. The second chapter reviews the literature on accessibility and urban quality of life and the third chapter reviews the literature on urban form. This literature review serves the purpose of offering the reader an overview of the development of accessibility as a central topic of discussion in urban geography and its related disciplines. Furthermore, the review serves to justify the thesis' central focus on urban amenities, which are essential elements in a city's liveability and quality of life. Finally, the review introduces discussions on urban compactness versus non-compactness, the elements of urban form, and how the form of a city is related to accessibility.

Chapter 4 introduces the operationalization of accessibility as a core component in any analysis on accessibility to services in the city. It provides a detailed explanation of the scale of analysis, the source data, and the methodologies used, including measurement approaches and distance measures. Chapter 5 and chapter 6 present and discuss the results of this analysis, including an evaluation of accessibility to urban amenities and an evaluation of urban form and its relationship to accessibility in the City of St. John's, respectively. In chapter 7, I offer concluding remarks and reflect upon future research opportunities and ways to build on this study.

Chapter 2 Literature Review Part I: Reaching liveability: the importance of accessible amenities in the city

Chapter 2 constitutes the first of two parts of this thesis' literature review. Reviewing the writing and musings of urban theorists and practitioners on how cities should be planned can help explain the significance of accessibility and accessible amenities, both in terms of the sustainability of a city and its inhabitant's quality of life. Especially so for smaller cities, the quantity and quality of urban amenities can make a difference in the ability of smaller cities to attract population and grow their economies (Robertson, 1997).

2.1. Exploring the functions of the city: Amenities, liveability and quality of life

American architect Louis Sullivan once wrote that "form ever follows function…where function does not change form does not change" (Sullivan 1896, 5). Sullivan was referring to the idea that architecture and the built environment should be reflective of its purpose (Rawsthorn, 2009). His words have had a lasting influence on architects and designers all over the world. In fact, modern architecture seeks to integrate the human and the social with the material and physical. Although function in industrial design has evolved away from the limitations of form – nowadays microchips store more capacity in less space – Sullivan's original idea still applies to city-making. A city's fundamental purpose is to provide an environment suitable for human habitat. In other words, cities must be *liveable* to the degree that they can fulfil humans' basic needs. These needs can only be fulfilled through the provision of equitable accessibility to urban amenities – the facilities and services that satisfy the needs of urbanites, makes places attractive for life,

and promote people's wellbeing (Allen 2015; Albouy *et al*, 2013; Witten *et al*., 2003). Considering these issues, I argue that for cities to be liveable, their function is to provide amenities that are *accessible for all*, regardless of one's physical ability or mobility. Someone on foot, for instance, should have the same capacity to reach a destination than someone driving a car, within a reasonable amount of time and effort. Indeed, it has been argued extensively that accessible amenities influence not only a city's long-term sustainability but are also important in attracting people and activity (Glaeser *et al*., 2001). Jane Jacobs's (1961) observations over five decades ago support this argument – cities only survive when they promote a diversity and mix of activities and people.

Liveability and quality of life (QOL) are important for all urban communities and a city's long-term sustainability. These two concepts have been used in urban research and writing to refer to the opportunities and pleasures that a city offers to its residents and the satisfaction people get from their surrounding environment (Ruth & Franklin, 2014; Mulligan *et al*., 2004). A city with a high quality of life or liveability typically provides a healthy natural and built environment, safety and security, affordable housing and mobility, job opportunities, and accessible municipal services (Timmer & Seymoar, 2006). In this way, QOL is influential at multiple scales: individuals and firms often make decisions to relocate on the basis of lifestyle and QOL and, as such, they are drivers of urban growth and competitiveness (Glaeser *et al*., 2001; Sirgy *et al*., 2000; Ley, 1996; Keeble, 1990; Campbell *et al*., 1976).

An increasing number of studies have devised various indicators to measure QOL, all of which are related to amenities. Raphael *et al* (2001) divided features of QOL by

their scale of impact: (1) individual well-being; (2) belonging; and (3) personal growth. These domains are influenced by the quantity and quality of amenities. For instance, physical and psychological well-being are supported by health-promoting amenities and other services or facilities. Spiritual wellbeing can be supported by the presence of social and religious amenities; while community belonging is affected by the availability of resources and services in general. Finally, personal growth is supported by the availability of activities and spaces that people can engage in regularly, such as school, work, outdoor and recreational activities, and other learning spaces. Other amenities and features that tend to be evaluated to rank cities by liveability or QOL include levels of employment, transit, walkability, accessibility, and crime rates, as well as people's perceptions and lived experiences (Marans & Stimson, 2011).

The fact that the presence, quantity, and quality of amenities can influence indicators of quality of life signifies that QOL and, by extension, urban liveability, depend on the successful and effective provision of services to all urban citizens. Jane Jacobs (1961) consistently argued that successful cities and neighbourhoods are made of bustling streetscapes, as spaces with people engaging in a myriad activities. Amenities are essential to building those streetscapes by attracting people and creating business and employment opportunities as well as promoting people to gather, to socialize and to invest in their community (Albouy *et al.,* 2013; Chen & Rosenthal 2008; Rappaport, 2008; Mathur & Stein, 2005; Altschuler *et al,* 2004; Clark *et al.,* 2002; Raphel *et al.,* 2001; Rogerson 1999). Put another way, the amenity is to the city as the atom is to the molecule.

Clearly, amenities provide goods and services needed for daily living. But on a deeper level, every amenity has embedded values that directly or indirectly contribute to liveability. Urban amenities can improve people' physical and mental wellbeing (Doyle *et al*., 2006; Frank *et al.,* 2007; Frank *et al*., 2004); they can reduce air pollution (Nowak *et al,* 2006); foster social interaction, build social and community capital (Francis *et al.*, 2012; Cattell *et al.,* 2008; Duany *et al*., 2000; Oldenburg, 1989); and constitute business and employment opportunities that generate tax revenue for the city (Glaeser *et al.,* 2001). The availability and accessibility of amenities are therefore vital factors for quality of life in the city and their neighbourhoods. These benefits are explored further in the following three sections.

2.1.1 Amenities and public life

Amenities contribute to building what Ash Amin (2006) calls the 'good' city (Amin, 2006), a space where citizens have the inherent right to a 'liveable' city regardless of their social or economic background. For Amin, the good city is built around solidarity, inclusion, and democratic engagement, which are all supported by public amenities. Public amenities are the most concrete representations of people's right to the city: to use public spaces freely, to congregate, to protest and to exercise their citizenship (Amin 2006). These inalienable rights call for the protection of public spaces and services, elements that are consistently eroded under neoliberal and corporate interests (Brenner *et al.,* 2012; Harvey, 2012).

Amenities support neighbourhoods. When the existence of amenities is threatened, residents often mobilise in order to protect the places and activities they cherish (Althuschuler *et al*, 2004; Raphael *et al*, 2001). Amenities can be vital resources that hold neighbourhoods together and create a sense of place and belonging. The stakes are high when it comes to failing or predatory amenities, such as closed-down old shops, on one hand, and new trendy chains wanting to come in, on the other. The former might signify that the community ceased to support the local economy and the latter may threaten the social sustainability of the neighbourhood through gentrification.

Amenities encourage communities to unite. By providing spaces where people can meet and socialize, public amenities set the stage for public presence and for collective and democratic community-building (Francis *et al.*, 2012; Catell *et al.*, 2008). Planning agencies and governments have had a renewed interest in public spaces and resources because they foster inclusion, reciprocity and trust; strengthen perceptions of safety; fight segregation; and ask urbanites to learn to cohabit in peace and negotiate conflict (Catell *et al.*, 2008; Amin, 2006). Finally, public spaces and facilities support a "public space consciousness," which creates a collective awareness of the value of places and the meanings attached to them, a process that not only facilitates the development of community identity but also creates a sense of purpose to maintain and protect what belongs to everyone. Amenities, then, are valuable public resources that not only make a city *liveable* but also *shareable.*

2.1.2. Amenities and health

Urban public health depends in great part on the consistent provision and upkeep of amenities (Jillcott *et al*., 2010; Doyle *et al,* 2006; Frank *et al.,* 2007; Frank *et al,* 2004; Evans, 2003). The most direct contribution towards good public health is the availability of health amenities that provide comprehensive health services, which includes a suite of health facilities (e.g. hospitals, clinics, family planning services, nursing homes, and pharmacies). In addition, there are a number of amenities that indirectly contribute to public health, such as recreational facilities, green spaces, cultural and social spaces, and food stores (Altschuler *et al.,* 2004).

Public health is also improved through physical activity (Haskell *et al,* 2007; Warburton *et al*., 2006). Environmental amenities, such as parks and walkable streets, are the most widely used amenities for physical activity (Giles-Corti & Donovan, 2002; Giles-Corti *et al.,* 2005) and it is well documented that wider use of public parks and streets helps reduce the risk of numerous diseases, including obesity, diabetes, and cardiovascular disease (Cutts *et al.,* 2009; Saelens *et al.,* 2003). Urban form is of central importance here, since well-connected street networks and more intensified and mixed land-use can translate to higher accessibility to amenities (Kaido, 2005).

The availability and quality of accessible amenities has a positive effect on mental health (Kling *et al.,* 2007; Evans, 2003). In the US, the Moving to Opportunity (MTO) program is featured in various studies on neighbourhood effects on wellbeing, in which the government relocated families from public housing projects in low-income neighbourhoods to higher-income neighbourhoods (Sanbonmatsu *et al*., 2011).

Importantly, all of the MTO studies found that mental health improves substantially after relocation (Sanbonmatsu *et al.*, 2011). This goes to show that the environment and the community infrastructure in which people live has a significant effect on their well-being.

The difference in outcomes in the MTO studies had to do with the fact that the higher-income neighbourhoods tend to either have better access to amenities, in particular green space and better-quality schools, or do not have so-called 'disamenities,' such as crime, pollution and traffic accidents. Disamenities can offset benefits from amenities that foster healthy behaviours, due to not only the physical dangers they pose but also because the mere existence of a few disamenities can reinforce risk perceptions from residents about the areas they live in, which can affect their psychological wellbeing. Risk perceptions and the attached emotional effects carry such a significant weight on residents that, for instance, Cutts *et al* (2009) found that minority and lower-income neighbourhoods in Phoenix, Arizona, which have a higher number of parks and walkable streets than higher income neighbourhoods, still suffer from higher rates of obesity. In a similar study, Doyle *et al* (2006) show that lower crime rates, in addition to a neighbourhood's walkability, present lower body mass indices. Mental health has a strong weight on quality of life and accessible amenities contribute to this significantly.

2.1.3. The economics of amenities

Urban amenities play a critical role in the economies of cities. Indeed, we need not look far to see how important amenities are for the economic viability of cities and regions. The current state of deindustrialized cities in the American rustbelt and in the English

Midlands offer important examples of the lasting impacts that lost urban amenities have on city budgets (Brenner & Theodore, 2005; Filion *et al.*, 2004). Many of the cities that survived systemic industrial decline and grew their economies often did so by developing post-industrial economies based on technology, finance and, above all, creative industries that made use of, or supported, amenities (Clark *et al.*, 2002). Moreover, the march toward globalization has accelerated the transformation of a number of urban economies away from production and toward key service sectors. The growth of the service economy has placed amenities in a central role: amenities are strategic both in attracting seemingly footloose firms and talent, and in increasing local wages and rents (Albouy *et al.*, 2013; Chen & Rosenthal, 2008; Rappaport, 2008; Clark *et al.*, 2002; Rogerson, 1999; Mueser & Graves, 1993; Roback, 1982).

Clark et al. (2002) show the economic importance of amenities in their assessment of 7,000 cities in 35 countries and conclude that most jobs in the post-industrial city are created in the information industry, which is associated with a socioeconomic class that is highly educated and highly paid. Such occupational status has led many to consume more cultural amenities, higher quality goods and services, as well as public goods. Citizens are effectively demanding higher quality of life, which drives the demand of amenities. Amenities, thus, take a central role in courting the talent and firms that are the mainstay of the *new economy* (Clark et al., 2002; Florida, 2002; 2005; Marans and Stimson, 2011).

Some scholars have taken the opposite direction in the jobs/amenities discussion, arguing that jobs are the central factor attracting talent, rather than the other way around

(Neidomysl & Hansen, 2010). Neidomysl and Hansen (2010) dissect this discussion further by surveying people in Sweden and found that jobs are the most important factor in deciding to relocate, for both men and women, and high-skilled and low-skilled workers. Despite the findings, however, the authors conclude that urban-economic regions that are able to provide various types of amenities have a competitive advantage in attracting talent, once employment and housing opportunities are fulfilled.

Even if jobs, not amenities, are the real cause for the migration of talent, there must be an equilibrium between the two factors to entice firms and people. That is, talented individuals that relocate for jobs typically demand amenities that fulfill both daily and wider lifestyle needs. Subsequent growth in amenities will, in turn, not only create more jobs (e.g. retail industry) but attract more talent and firms. This relationship is especially characteristic of large and growing cities. For instance, in Canada, Albouy *et al.* (2013) found that among 33 CMAs and 13 non-CMAs, the CMAs with the highest quality of life (QOL) tend to be Canada's largest metropoles, which also have above average productivity levels. Chen and Rosenthal (2008) found that the workforce follows high-quality business environments (e.g. good jobs), and that firms tend to prefer large, growing cities. This shows that if firms locate in larger cities and workers move to these, they are also moving to places with higher QOL, which even if not the main attractor, it becomes a secondary source of talent retention and economic growth.

If amenities are vital for a city's quality of life, so is their accessibility. Without an accessible provision of services and facilities, residents cannot enjoy their right to the city and their quality of life may be diminished. In this way, amenities, liveability and the

functionality of cities is tied to accessibility, which, in turn, is tied to the form of the city. In the following subsections, we explore accessibility, and their relation to amenities and to urban form.

2.2. Accessibility: What it is and why it is important to quality of life

> …what keeps residents in metropolitan areas is accessibility, the potential for interaction, both social and economic, the possibility of getting from home to a multitude of destinations offering a spectrum of opportunities for work and play (Niemeier and Handy, 1997, 1175).

Transportation and planning scholars Niemeier and Handy (1997) highlight that accessibility makes metropolitan areas attractive to people. In other words, accessible amenities are critical to a city's livability. Considering that my analysis below interrogates the important relationship between accessibility and liveability, it is important to first unpack these key themes.

So, what is accessibility? This theme has long been understood in relatively simple terms: the availability of destinations and the distance between origin and destination (Niemeier and Handy, 1997; Thomas and Penchasky, 1981). In recent years, however, accessibility, both as a concept and a practice, has rapidly evolved, from its focus on the material and the quantitative, to more qualitative and sociocultural interpretations and methodologies (see Hall & Barrett, 2012).

In the positivist tradition, accessibility depends on centralization. Christaller's classic "central place" theory guides this "urban logic", positing that long-term viable activities and services 'naturally' consolidate in central, often urban, locales (King,

1984). The people close to the center – or where amenities consolidate – have higher accessibility. This urban logic is integral to a wide range of urban thinking and contemporary urban design, transportation and retail (DeMarco and Matusitz, 2011; Rodrigue, 1975; van Otten and Bellafiore, n.d.)

A positivist approach, however, is not sufficient to evaluate accessibility. Accessibility is messy and complex, and contains deeper social, economic and political aspects that impact people differently across different spaces and scales (Talen and Anselin 1998). While positivist definitions of accessibility focus on quantifying distances, measuring geometries and counting destinations, critical definitions of access have focused on the users' different abilities and subjectivities to access destinations as influenced by a variety of spatial externalities (Nicholls, 2001; Talen and Anselin, 1998). For instance, Niemeier and Handy (1997) extend their definition of accessibility (above) to include the level of *quality* and *character* of services and facilities as critical to any evaluation of access. This interpretation provides a degree of *subjectivity* – different people may perceive quality differently – and of *fairness* – quality may vary greatly from higher-income to lower-income neighbourhoods. Furthermore, Nicholls (2001) and Talen (2003) argue that a destination is accessible according to the level of ease to reach it, which can be affected by differences in access to transport (e.g. car owner vs non-owner), age (e.g. children and senior are less mobile), and one's physical mobility.

We must note, however, that both dimensions of accessibility – positivist and post-positivist – complement each other. Indeed, quantifying access through average distances between origins and destinations is a necessary step to understand accessibility,

but an assessment of demographic and business information, such as total population and types of products offered, serves to paint a more complete picture. One result of a complementary approach is that we gain critical perspective: food deserts – areas with lack of healthy and affordable food – for instance, can be made visible in areas with higher population numbers, lower quantity and higher dispersion of food stores, and lower quality of products. Clearly, integrating the two dimensions is key not only towards a better assessment of accessibility but also towards a global understanding of the importance of equality of accessibility for urban democracy. With an eye to elevating the critical capacity of accessibility, the present study conducts an evaluation of accessibility and spatial equity in regards to access per capita, and in doing so provides a more comprehensive and just approach.

In line with the more critical interpretations of accessibility, scholars have turned their attention to the role of this urban metric in cities' *liveability* and *quality of life* (Timmer and Seymoar, 2006; Lynch 1999; Smith *et al.*, 1997). Recently, Allen (2015) and Raphael *et al.* (2001) found that many of the participants interviewed associated the ability to access amenities with perceptions of quality of life. One reason for this may be time. For urbanites dealing with congestion and other daily time and spatial disturbances, time can easily become scarce (Mackie *et al* 2003; Mackie *et al.* 2001), drastically impacting people's quality of life (see Dougherty and Burton, 2017 and Miller, 2017 for examples of extreme commuting in large cities and its effects on people's lives). Time spent moving is drastically reduced as facilities, goods, services and people are closer together.

Beyond the accompanying reduction in travelling time, accessibility to urban '(dis)amenities' – their number and location – can have a negative or positive effect on people's perceived quality of life. The presence and proximity to crime and environmental pollution, for instance, are detrimental to a neighbourhood's livability, while being close to green areas, public commons, safe streets, employment, high-quality schools, and public transit has the opposite effect (Khalil, 2012; Cattell *et al.*, 2008; Atschuler *et al.*, 2004). The existence of functioning amenities improves people's urban lives: maintained public spaces provide a sense of good government, an opportunity to exercise one's citizenship and interact with fellow citizens; green space and controlled environmental pollution and crime assure urbanites' physical and mental wellbeing; abundant employment and high-quality schools guarantee the long-term sustainability of a city by continually attracting new residents.

The growing significance attributed to quality of life and, in turn, to accessibility, is manifested in the expanding popularity of international rankings of cities and real-estate assessments of local neighbourhoods in terms of their liveability and walkability, which effectively measures a place's worthiness. In many cases, cities' (and neighbourhoods') success in attracting business and workers depend on their ability to provide a high quality of life and an attractive community infrastructure, and rankings make these efforts public. In today's highly globalized and interconnected world, where industry and people are no longer localized but increasingly mobile, cities find themselves competing for human and financial capital (Rogerson, 1999).

Rankings of quality of life also help promote places and they often dictate urban policy that seeks to attract investments. Partially because of this growing 'bidding war', planning has been guided by profit maximization, leading to socio-spatial inequalities and inequities. In today's cities, a small share of the population benefit from global investments; the numbers reflecting cities' 'quality of life' are exclusionary, appropriating the concept to describe the lives of a few (Rogerson, 1999).

2.2.1 Livability is not for all

As explained in the previous section, liveability and, in turn, accessibility, is exclusionary. Awareness of socio-spatial inequalities in urban spaces was catapulted in part thanks to the global urban upheavals of 1968 and the struggle for civil rights in the same decade, in which cities across the world became the stage and site of contestation for the right to urban life, both in practice and in theory. Writing in the same year, French Marxist philosopher-cum-geographer, Henri Lefebvre (1996 [1968]), initiated a critical conversation of urban space with his widely popular book, *The Right to the City* (Marcuse, 2009). Lefebvre argued that the city was more than a material entity designed and constructed by architects and bureaucrats. The city's form and function should be directed and swayed by the social needs of urban society (Lefebvre, 1996 [1968]). Lefebvre (1991) wrote that people in cities have "the rights to use multiple services, the right…to make known their ideas on the space and time of their activities in urban areas" (Lefebvre 1991, p. 34). The city is made of people who work and play, who engage in

daily life; a city without people is simply a collection of buildings and roads. Simply put, for a just city to exist, its people must have a right (or access) to urban life.

Following Lefebvre, geographer David Harvey (2010) has consistently and fervently drawn attention to the injustices and inequities taking place in cities. Poverty in core urban areas and lack of access to services and goods were dissected under the academic microscope (Harvey, 2010). Harvey's influence has been incalculable as research and writing in urban political-economy has since expanded to include rich analyses of the rising socio-spatial inequalities in cities around the world (Hulchanksi, 2010; Glaeser *et al.*, 2008b). Such research has uncovered the realities of the contemporary neoliberal city as certain socio-economic groups enjoy greater access to the city and its various services and infrastructures as well as greater levels of wellbeing (see Sampson, 2017; Lo, 2009). The privatization of urban space is a fundamental aspect here (Francis, 2016; Brenner *et al*., 2011; Brenner and Theodore, 2002). Privatization is part and parcel of the neoliberalization of cities across the global north (Peck *et al.*, 2009), where the wealthy and the corporatized state wield increasing power and influence in the outcomes of municipal decision-making relative to the average citizen (see: Gilens & Page, 2014; Purcell, 2002; Swyngedouw, 1996). Many of these transformations not only exacerbate but legitimize urban injustices, in the form of reduced supply of affordable housing (Emmons 2016), the segregation of communities through the construction and undemocratic placement of urban infrastructure[1] (Bayor, 1988), lower quantity and

[1] Robert Caro's (1974) biography of (in)famous New York City planner Robert Moses describes in detail the process by which Moses used the construction of highways as a tool of social engineering.

quality of services in areas of need (Ottensman, 1994; Larsen & Gilliland, 2008), gaps in a wide-range of affordable retail (see Williams & Hubbard, 2001; Alwitt & Donley, 1997), and unwalkable streets (see Neckerman *et al.*, 2009).

To be sure, contemporary urban planning practices have legitimized and institutionalized these and other urban injustices, many of which are directly connected to inequitable accessibility. The vast majority of North American cities and their planning institutions, for instance, covet automobility in decisions concerning infrastructure investments and new developments. One need not look too far as the language found in traffic design manuals, which do away with pedestrians' right to use roads as spaces for social interaction and simply treat roads as 'traffic channels' in order to move car traffic efficiently (see Schmucki, 2012; Lo, 2009; Forsyth and Southworth, 2008). In addition to streets, parking space allocations disregard non-drivers: businesses are required to provide many times their building size in parking space, significantly reducing accessibility for the pedestrian (see Kimmelman, 2012; Shoup, 1999). Access for non-drivers has yet to be taken seriously by transportation and urban planners (Talen, 2003; Niemeier and Handy, 1997). Despite gains in densification, mixed-use policies and incentives for walking, the recent population growth in car-dependant suburbs (Frey, 2017) shows that the majority of people are still driving and likely commuting to the city by car, and cities are responding by investing in highways and disinvesting in public transit.

Despite these shortcomings, scholars see accessibility as a bridge between engineers' and planners' divergent visions of the city (see Talen, 2003), as a complex

concept that blends a 'spatial logic' of distance and time efficiency and a 'social logic' of equity and justice. Through planning for accessibility, planners could start to incorporate notions of justice in the design of urban space by working towards a comprehensive vision that begins from an ethical space, that is, *access for all* (see Fainstein, 2010). This thinking is supported by many urban scholars and professionals who argue that modern planning should have justice as a clear starting and end goal in its practice (see Zapata & Bates, 2015; Soja, 2009; Carey, 2006; Fainstein, 2005; Talen, 1998; Campbell, 1996; Lucy, 1981).

Incorporating equitable accessibility as a guiding principle in city planning requires a way to make equity more tangible in planning terms. Lucy's (1981) principle of *equity as need* is an important place to begin. Here, equity as need argues that justice is achieved when amenities of reasonable quality are distributed in such way as to provide goods and services according to people's needs (Lucy, 1981). Hence, planning for need signifies that "those needing more service should get more, rather than less" (Lucy 1981, 448). According to Ircha and Sundararajan (1984), 'equity as need' produces the fairest distribution of goods and services in the city. Acknowledging that not every neighbourhood is the same and that the city is spatially *unequal* implies that the distribution of amenities should also be unequal. Those areas, such as inner-city neighbourhoods which have older infrastructure and that tend to lack open space, need *more* amenities (Ircha & Sundararajan, 1984) and planning efforts should be directed towards that goal.

Considering this broad support for planners and city governments to take on a more definite role in equitable access and urban equity in general, we must ask: Who is responsible? If most people drive, should the minority that do not own a car find other ways to access services? Does the government bear responsibility or does the individual? Put another way: For whom is the city built? Philosophers, political scientists, urban scholars, geographers, and planners have attempted to answer this question for thousands of years. As far back as Ancient Greece, Plato argued that justice was defined by the actions of the State, and liberal philosophers argued for the equal provision of services to all citizens (Ircha & Sundararajan, 1984). More recently, Witten (2002) maintains that central and local government agencies have the responsibility to provide community resources, which Ircha and Sundararajan (1984: 34) consider "the *raison d'etre* of local government." Furthermore, Marcuse (1978) and Merget (1979) contend that given the provision of a public service by a community, equal access must follow. Therefore, planning for equity is not only a noble goal of municipalities, but it is also a requirement (Commonwealth of Massachusetts, 2000; Cutter, 1995).

As with most aspects of city making, achieving justice and equity in cities has proved difficult. During his tenure as Director of the Cleveland City Planning Commission, Norman Krumholz (1982) wrote about his experience during the administration of the first Black mayor of a major city in the U.S. and describes the obstacles that marred attempts to build equity through spatial planning. Krumholz and his staff drafted one of the first planning policies that prioritized equitable provision of urban services and opportunities over traditional land use planning (Metzger, 1996). As a rust

belt city, Cleveland experienced dramatic social and structural change: a rapid decline in population and economic activity, a rise in low-income and ethnic minority populations in the city center, and growing city-suburban disparities. Additionally, zoning policy, the classic planning tool, exacerbated the segregation of minorities, who had little to no influence in municipal affairs (Krumholz, 1982). One equity project Krumholz took on was to increase mobility for the poor by reforming the city's public transit system, which a third of all of Clevelanders used. Management was transferred to the regional authority, fares were reduced, service frequencies and coverage was expanded, and access to seniors and the handicapped was improved. Nevertheless, Cleveland continued to decline and its urban inequities kept mounting.

Following other cities experimentations with equity planning, the government in Cleveland resorted to top-down approaches with little participation from the public. In the years that followed, however, Krumholz witnessed increasing public participation and advocacy in urban issues, with organizations springing across Cleveland and other cities aimed at fighting for the right to the city. As a result, numerous cities sought reinvestment in their downtowns throughout the 1980s (Metzger, 1996).

One key lesson from Krumholz's story is that those that are affected by planning decisions are ultimately responsible for shaping planning policy. A key step forward therefore is to build public consensus through meaningful collaborative planning (Innes and Booher, 2004; Innes, 1996). In this case, public consultation and collaboration via town forums, design charrettes, and visioning processes decentralize and collectivize the planning processes and reduce tendencies for political power plays that configure urban

space in line with those in power. While municipal governments have a legal and moral responsibility to provide accessible resources to its citizens, it is up to the community to organise and negotiate with planners and politicians in order to reach collective visions of their cities.

2.2.2. Growing spatial 'gaps'

While leading urban scholars talk of the convergence of different activities and diverse people as a defining feature of the contemporary city (Mumford, 1937; Jacobs, 1961)[2], cities today are not providing equally or equitably accessible amenities to their residents. Most North American cities have shifted from serving people to serving business (Brenner *et al.* 2012; Harvey 2012). This is a story well told: while a city's normative function is to serve its citizens (largely understood as tax paying people), this is rarely the reality (Ngom *et al,* 2015; Alwitt and Donley, 1997; Ircha & Sundararajan, 1984; Krumholz, 1982). With a change in priorities has come a change in urban form. The average city, for instance, has expanded significantly in land area by paving their way outwards from their downtown cores, maintaining low densities, building low-rise buildings and single detached houses, and zoning vast portions of the land for single-use developments (Hamidi *et al.,* 2015; Ewing, 2008; Batty *et al.,* 2003; Chin, 2002; Galster *et al.,* 2001; Brueckner, 2000; Duany, *et al*. 2000).

[2] This idea is one long promoted by urban theorists and advocates, such as Jane Jacobs and Lewis Mumford. The former advocated for a city landscape that allows people to mix and for which a diversity of activities is needed. Mumford advanced the idea of cities as making collective life more dramatic and intense.

This new reality constrains accessibility, amenities and, in turn, liveability for all. These socio-spatial gaps can be explained by the historical transformation of urban systems. The life of many low-income and working-class urbanites has been drastically upended by forces out of their control: an inherently unequal global socio-economic and political system (see Shannon, 2014; Bedore, 2013; Brenner *et al.*, 2012), the socio-spatial polarization of urban agglomerations (Cassiers and Kesteloot, 2012; Ley and Lynch, 2012; Bunting *et al.*, 2004; Walks, 2001); the intensifying privatization and corporatization of cities, public spaces and services in the quest for capital growth (Hirt, 2013; Brenner *et al.*, 2009; Mitchell, 2003; Pirez, 2002; Byers, 1998), and the increasing gentrification of, and exclusion in, urban neighbourhoods (see Lynch & Pottie-Sherman, 2016; Lees, 2008; Walks and Maaranen, 2008; Smith, 2002). In the process, the traditional main street of downtown areas has been radically transformed into a series of strip malls built on cheaper land in the urban fringes, which exist to benefit only those who can afford a car (Shoup, 1997). Cities are responding to, and zoning and building for, the car and the new tax revenues from unfettered development, which has led to sprawl and decentralization of commercial activity. The transformation of the contemporary urban form is affecting peoples' accessibility and quality of life, further alienating urban dwellers.

Constraints to access in cities around the world abound as reflected in the wide literature on the matter. Shah *et al* (2016) found wide spatial disparities in access to primary care services across Canadian neighbourhoods and between 14 Canadian cities, in which some cities showed higher accessibility than others, and where neighbourhoods

with low access to family physicians clustered in the metropolitan periphery and on the edge of downtown areas. Similarly, Schuurman *et al.* (2010) found wide spatial disparities in health access within Nova Scotia, with larger agglomerations enjoying significantly higher access than rural areas. Unequal and inequitable access to health amenities directly affect public health.

Accessibility to urban parks and green areas shows socio-spatial disparities as well. Ngom *et al.* (2016) studied equity in access to green spaces in both Montreal and Quebec City Census Metropolitan Areas (CMAs). Their findings show higher levels of access to green spaces in the Quebec City CMA, a context where parks are more evenly distributed across socioeconomically differentiated areas. Conversely, Montreal has less access but better investment on fewer green spaces in some of the densest areas of its CMA. These parks, however, are overwhelmingly located in highly gentrified and socially stratified neighbourhoods.

In Seoul, Korea, Oh and Jeong (2007) found spatial inequalities and inequities in park availability (i.e. the number of parks) and their serviceability (i.e. location of parks with respect to users) between areas north and south of the Han River. Whereas the northwest areas and southeast neighbourhoods of the city showed similar park area ratio and park area per capita, both determined by park area and population, the southeast presented the highest service area ratio and service population ratio. While both parts of the city had almost *equal* park area ratios, the southern areas of Seoul had more *equitable* accessibility and thus more parks for more people.

Constraints to accessing parks and health services are also a consequence of constraints to accessible and reliable transit, a determining factor of accessibility in cities. Put simply, greater distances from households to amenities directly impact carless households who typically rely on alternative modes of transportation. In particular, low-income and poor households need public transit, which explains their concentration in inner-cities in the U.S. (Glaeser *et al.*, 2008a; Garrett and Taylor, 1999) and, at times, these groups experience limited accessibility to transit due to lack of investment in transit systems (McKenzie, 2013; Bromley and Thomas, 1993).

On the other hand, a significant portion of urban activity takes place in private establishments, such as fitness centres, shopping malls and cafés. The distribution of private amenities is typically more spatially constrained than public amenities, which 'follow the money' to optimize profits[3]. Here, private amenities are liberated from the 'burden' of limited public finances, and thus follow the supposed 'free' market (Grant and Perrot, 2011; Grant, 2009; Hernandez and Simmons, 2006; Filion *et al.*, 2004; Filion, 2003; Grant, 2002; 2001; Robertson, 1997; Shrimpton and Sharpe, 1980). The reduced accessibility of private amenities is a strong constraint to urban accessibility for all. This, in turn, is made worse by the growing privatization of certain public services and spaces.

Food provision and security is a clear victim of profit maximization and aggressive locational decisions, leading to diminished accessibility. Food 'deserts' are

[3] see Hobbs et al. 2009, 2-12 for a detailed explanation on public vs. private goods; Macintyre *et al.* 2008 found that among several public and private amenities in Glasgow, more deprived neighbourhoods had less access to private schools, cafes, tennis courts, bowling clubs, private health clubs and private swimming pools, while having more access to public amenities.

areas with little to no provision of healthy food (Cummins and Macintyre, 2002; Reisig and Hobbiss, 2000) and are now prominent features of many cities that have undergone suburbanization and decline (see Walker *et al*., 2010; Beaulac *et al.*, 2009; Larsen & Gilliland, 2008). While food deserts are found both in higher-income as well as in lower-income neighbourhoods (Walker *et al.*, 2010; Larsen & Gilliland, 2008; Apparicio *et al.*, 2007), accessibility to quality food also rests on two other factors: people's ability to reach a grocery store and their ability to afford it. Higher-income urbanites are more likely to own or have access to a car, granting them easier access to stores outside of their neighbourhoods, or rather, they can afford the higher prices of convenience stores or even restaurants.

When affordable supermarkets are not readily available within walking distance, less mobile households have to either spend more of their income on food (e.g. prices in convenience stores and minimarkets are much higher) or rely on alternative modes of transportation to get to these stores, which limits the time they have to shop (Rose & Richards, 2004). Weinberg (1995) found that the lowest income neighbourhoods in US cities have about 30% fewer supermarkets than the highest income neighbourhoods, and other studies have found that food deserts are disproportionally found in low income neighbourhoods (Giang *et al.*, 2008; Glanz *et al.*, 2007; Morland & Filomena, 2007; Alwitt & Donley, 1997; Cotterrill and Franklin, 1995). Constrained accessibility does not only weigh on people's pockets but also their health. A lack of supermarket access leads to over-reliance on lower-quality food venues which are associated with poorer health

outcomes (Smoyer-Tomic *et al.*, 2008; Hendrickson *et al.*, 2006; Lewis *et al.*, 2005; Block *et al*., 2004).

Chapter 3 Literature Review Part II: In search of an accessible urban form

3.1. Does form follow function?

American architect Louis Sullivan said that "form ever follows function" (1896, 5). While he referred to the building as an integrated unit, it can be said the same of cities. However, in this case, there is not as much integration. Urbanites are experiencing widening socio-spatial gaps in accessibility and service provision in many of the world's global cities, and this *dis*function is reflected in cities' form. Planning practice has deviated from theory: while many of the major urban thinkers advocate for compactness to increase accessibility and, thus, liveability for all, planners and city officials' decision-making has been guided by the endless pursuit of capital growth.

Planning operates in two dimensions – the ideal and the real. In an ideal world, 'liveability for all' would require that all dwellers can move around the city in an affordable, sustainable, and efficient way, and can readily fulfil their daily needs. Contemporary planning thought in western cities, shaped by the planning movements of the past, supports self-contained neighbourhoods, a concept also preached by sustainability and climate action advocates (Choguill, 2008). A liveable city presents a particular urban 'imaginary', a form that follows a specific function: a sufficiently compact size with mixed densities; walkable, safe and connected streets; and mixed land use. Such an urban form enables cities to fulfil people's needs in an accessible, health-promoting, safe, green, affordable and equitable way (Talen, 2002a; 2002b; Kaido, 2005). For that reason, form matters to function.

But what is that ideal form? To answer this question, it is important to understand what urban form is and how it relates to accessibility. The following section discusses urban form in detail.

3.1. Urban form: what it is and how it influences access

Access is intrinsically related to urban form (Talen, 2002a; Ewing, 1997; 1994; Lynch, 1984). Urban form consists of a city's size, density, land use and street network (Oliveira, 2016; Hamidi *et al.*, 2015). All these elements shape accessibility. Kevin Lynch, a renowned planner and urban theorist, considered access a vital element of the ideal urban form, where activities are well integrated, and people enjoy good accessibility to all things (Talen 2002a; 2002b).

The morphological study of the city is an alternative way to understand complex urban systems. It is a hierarchical system composed of urban 'tissues', each of which can be studied at various scales, resembling the study of organisms (Oliveira 2016; Scheer 2001). The urban form has two types of elements: physical and spatial. The former includes streets, street blocks, plots, and buildings (Oliveira 2016; Scheer 2001). The latter refers to the spatial organization of physical elements. This includes centeredness (e.g. the existence, location and distribution of clusters or centers of activity), density (e.g. number of people and dwellings by square meter), land use (e.g. the legally assigned function of a piece of land, such as commercial or residential) and street networks (Hamidi *et al.* 2015). The various ways in which these elements overlap generate

different identifiable tissues, some of which give a city a unique and recognizable shape (Oliveira 2016; Scheer 2001).

The elements of urban form have their own measurable dimensions. Galster *et al.* (2001) present several of these dimensions to define sprawl and, Song & Knaap (2004) apply it to the study of the urban form. The street network's form can be measured by its connectivity: number of nodes and intersections, number and lengths of blocks and cul-de-sacs, and distance between origin and destination points (Song & Knaap, 2004). Density can be measured by the size of the lots, the density of houses and buildings, and their floor space. Land use mix can be measured as a ratio of size of actual/zoned non-residential land to size occupied by residences.

These elements come together to give form and 'personality' to neighbourhoods and cities. How these elements overlap and what their dimensions are depend on the natural environment in which the city was built. For instance, natural topographies on which cities are founded can significantly shape its street layout (Oliveira, 2016). While some cities built on hills, like San Francisco, opted to build modified grids, other cities, like St. John's, built their streets following topographical characteristics.

One of the most defining elements of the urban form is the street system (Oliveira, 2016). Streets act as the veins and arteries of the urban circulatory system (Song & Knaap, 2004). Indeed, it is through these features that people move across the city and access goods and services. As such, the street system is a powerful planning element to facilitate or constrain accessibility to urban users and remain as the most stable element of urban form (Oliveira, 2016; Scheer, 2001). The dimensions of streets

are the features that make them more or less accessible, safe, and inviting. A wider street allows for a higher number of modes of transportation and protected lanes, increasing accessibility, mobility, and safety. However, if a street is too wide, especially with respect to the buildings on either of its sides, pedestrians can feel unwelcome and unprotected, and intersections can be dangerous (see Duany *et al*., 2000; Ewing *et al.*, 2006). Put short, the prevailing view by planners and architects holds that streets should be able to accommodate various forms of transportation but do so without compromising the 'human scale' (Ewing *et al.*, 2006).

Street blocks in a city also have a significant effect on form and activity and are the building blocks of a street network. Perhaps most importantly, blocks separate and define the private and public domains in the city (Oliveira, 2016). Blocks have a long-term effect on the form of the city and their dimensions determine what type and how many buildings can be built in them. Collectively, blocks determine the building density of the city and dictate or influence land use, with central areas often having a higher density of smaller blocks than peripheral areas (Oliveira, 2016). Like streets, blocks and buildings have a direct effect on accessibility. With larger plots come longer streets and larger neighbourhood size but also constraints to pedestrian accessibility. A higher density of larger buildings, on the contrary, makes access for pedestrians easier, as there is more room for residential and commercial development, and developments are closer to each other.

Together, smaller blocks, closer buildings, and more connected streets help increase access for pedestrians. This design philosophy is at the heart of much

contemporary planning literature but remains a key point of debate: is there an urban form that optimizes accessibility? Contemporary urban scholars have approached this central question by exploring three key points: i) sprawl decreases accessibility; ii) compactness is the opposite to sprawl and, thus, should help increase access; and, iii) design features that increase walkability and reduce car use integrates urban activities and people and, thus, increases accessibility for pedestrians. It is imperative to explore these three points in order to understand how urban form affects the functionality and liveability of cities and how certain forms may be superior in achieving this.

3.2. Compactness versus sprawl

Geographers and planners have written extensively about urban sprawl and offer several key insights. Researchers highlight that sprawl is a complex socio-cultural phenomenon with a long history (Fishman, 2008). As such, sprawl has received the attention of hundreds of articles, volumes of books, and six comprehensive literature reviews. There is an agreement in the literature that sprawl is negative and anathema to compact urban design and urban liveability and sustainability (Ewing, 2015; 2008 [1994]; 1997). Although there is opposition to the idea of compactness (see: Neuman, 2005 and Gordon and Richardson, 1997) there is still, among some of these authors, a certain acknowledgement of sprawl's shortcomings.

Sprawl is loosely defined as unsustainable, low-density, and discontinuous development located far from the urban core areas and fundamentally car oriented (Batty *et al.* 2005). Ewing (2008 [1994]) defines sprawl as the unplanned spatial expansion of

cities due to demographic growth, and Bruckner (2000) defines it as "excessive spatial expansion of cities" (Brueckner 2000: 161). Of course, there are degrees of sprawl. The higher the degree of sprawl, the worse its impacts are, making certain patterns of development "undesirable" or "desirable" (Ewing, 2008 [1994]).

Galster *et al.* (2001) argue that there is much confusion surrounding sprawl as a concept since sprawl not only exists in degrees but is also tied to context. In other words, sprawl has geography. Indeed, some commentators explain sprawl as a 'condition', as a 'process', as a 'cause', and some as a 'consequence'. While there is little consensus on an empirical definition, Galster *et al.* (2001, 685) offer a compelling case in order to "move from polemics to a common understanding and useful analysis of urban form". For these writers, sprawl is best understood as:

> A pattern of land use in an urban area that exhibits low levels of some combination of eight distinct dimensions: density, continuity, concentration, clustering, centrality, nuclearity, mixed uses, and proximity. (Galster et al. 2001, 685)

Galster *et al.* (2001) and Ewing (1997) agree, then, that sprawl can occur at different levels along a spectrum, where one end is absolute sprawl (i.e. long and disconnected streets, low density, single-use neighbourhoods) and the other end is absolute compactness (high density, short and highly connected streets and highly mixed land use). But this definition begs the question: Is sprawl or compactness more desirable as a planning principal?

Gordon and Richardson (1997) argue against compactness. They explain that low-density settlement is the preferred form of residential living in the U.S. and, to an extent, in Canada. They dismiss the idea that restrictive zoning can prevent low-density

development, but do not provide enough evidence. With respect to planning for access, such as New Urbanist developments, the authors argue that these projects have not done much in favour of alternative modes of transportation, and instead increase vehicle miles travelled, the exact opposite of their intent. However, the evidence for the shortcomings of compactness presented is lacking, and the authors show more support for the long-standing belief that sprawl does cause higher costs for municipalities and states.

Ewing's (1997) response to Gordon and Richardson (1997) begins by pointing out that his own view of compactness is not necessarily high-density and mono-centric, but that it rather requires a certain level of housing and employment clustering and mixing, which implies higher than low-density, but not necessarily levels seen in cities like Hong Kong. Again, most types of development fall on either side of the sprawl-compactness spectrum, but what ultimately matters, according to Ewing, is the degree of sprawl or compactness and its impacts on development patterns. For Ewing (1997: 109), the clearest indicator and impact of a high degree of sprawl is poor accessibility: either poor residential accessibility, if "residences [are] far from out-of-home activities," or poor destination accessibility, if "out-of-home activities [are] far from one another". Poor accessibility in cities is caused in part by low-density and scattered patterns. In contrast, compact urban forms – higher densities, mixed land-use, and smaller street blocks, connected streets and one or many centers of activity – present higher accessibility to services (Hamidi *et al*. 2015; Ewing *et al.* 2002; Ewing 1997).

In a study of accessibility to facilities in forty-nine Japanese cities – large, medium and small agglomerations – Kaido (2005) concludes that high density and

accessibility are highly correlated depending on the amenity in question and the size of the city. In addition to density, the street network impacts access significantly. In compact forms, street blocks are smaller; there are more intersections, in general, and four-way intersections, specifically; and streets are designed in such a way as to attract pedestrians and increase *walkability* (Hajrasouliha & Yin, 2015; Hamidi *et al.*, 2015; Duany *et al.*, 2000). Furthermore, land use has a great impact on accessibility. Compact forms have mixed and integrated land uses that increase access for pedestrians while non-compact forms segregate uses and make it harder for people to get from point A to point B (Hamidi *et al.* 2015; Filion *et al.* 2004; Frank *et al.* 2004; Cervero 1996; Grant 2002). Finally, the centeredness of a city determines whether activity – commercial, residential and employment – concentrates in a same location and to what degree. A compact city is defined as one that has concentrations of employment within three miles of central business districts (Hamidi *et al.* 2015).

It is not just a matter of who has the last word, but what the real consequences of sprawl are. Non-compact urban forms are known to give rise to a host of environmental, social and economic issues. On one hand, sprawl has been highly detrimental to cities: not only has it been described as 'anaesthetic' (Duany *et al.*, 2000), but it has also been referred to as economically inefficient and environmentally and socially damaging (Hamidi *et al.*, 2015). Sprawl has resulted in higher infrastructure costs as utilities and other urban services started to spread out to cover additional space (Batty *et al.*, 2003). Highways, vital to the diffusion of urban space, also carry a high economic cost: studies have shown that they never pay for themselves as the cost is borne by the tax-payers,

whether they use the infrastructure or not (Mann, 2014). This means that suburban residents 'free ride' on urbanites by using the highway system, while exacerbating problems for those who reside in cities. Environmental costs include the bulldozing of arable farmland and green space, higher carbon emissions and air pollution (Grant, 2001; Ewing, 1997).

As mentioned above, sprawl has accelerated socio-spatial polarization between suburbs and inner-city areas and has negatively impacted communities' social capital (Hulchanski, 2010). Highways and ramps in US cities, for instance, have led to spatial and social divisions in urban communities, segregating and isolating the most socially vulnerable (Semuels, 2015). This phenomenon has been observed since the beginning of the construction of the Interstate Highway System in the United States in 1956. The focus on efficiency and accessibility to the city by car broke communities apart, in particular African-American communities living in the inner cities. Although Canadian cities have not witnessed the same levels of socio-spatial segregation among ethnic groups taking place in the US, which is a key difference in discussions of urban justice between the two countries, there are examples in Canada of increasing gentrification and polarization, with visible minorities concentrating in low-income housing, decreasing ethnic diversity in gentrified areas, and, more generally, a widening income gap between recent immigrants, visible minorities and Indigenous Canadians and the rest of Canada (Monsebraaten, 2017; Walks & Maaranen, 2013; Walks & Bourne, 2006).

Sprawl has, at least partially, led urban core areas to fall into disrepair. As an example, downtown areas in the U.S. Rust Belt have been in gradual decline for decades,

not only because of segregation, but also due to white flight and the relocation of businesses to cheaper suburban areas (Howe *et al.*, 1998). As people moved to the suburbs, tax revenues in many cities shrank significantly (Howe *et al*, 1998), affecting the ability of municipalities to provide urban services to their residents at the same rate as in the past (Squires, 2002), such as education (Semuels, 2016). With service provision affecting mostly low-income and minorities who reside in cities' inner cores, urban areas have become more inequitable and socially deprived (Batty *et al*., 2003). This has affected low-income residents, university students, and ethnic and racial minorities, while suburbs are almost exclusively populated by a high-income white majority (Filion *et al*., 1999). In short, sprawl worsens socioeconomic inequality in the city to a significant degree. Again, the difference here between the U.S and Canada is significant. The urban history of Canadian cities does not correlate to that of cities south of the border. On one hand, the racial factor in the segregation and deterioration of the inner city and the expansion of suburbs does not, for the most part, exist in Canadian cities. In fact, there are major ethnic suburban enclaves outside of major cities like Toronto and Vancouver, and many of these communities are high or middle-income ones. On the other hand, Canadian downtowns have not experienced the decline in levels observed in U.S. cities and some cities, such as Toronto and Vancouver, have densified and have invested heavily on their transit systems, making Canadian cities more compact in relative terms (Goldberg & Mercer, 1980).

What both Canada and the US do have in common in relation to their urban histories is that, in both countries, sprawl is a reality, albeit on different degrees and

scales, and has been accompanied by a change in the urban landscape. One of the most visible changes has been the proliferation of retail power centres (Seasons, 2003; Hernandez & Simmons, 2006) and industrial/office parks (Hartshorn, 1973) in sparsely distributed suburban strip malls far from urban cores areas and in close proximity to highways and major roads (Ewing, 2008; Hernandez & Simmons, 2006; Couch et al., 2005; Chin, 2002; Torrens and Alberti, 2000; Alzubaidi et al, 1997; Millward & Winsor, 1997). Power centres are nodes of big box retailers sharing a parking lot and connected through costly highway systems. This consolidation of retail capital (Crewe, 2000; Ducatel & Bromley, 1990) has been made possible by, first, the dominance of the car and the investments in car-friendly infrastructure (Shoup, 1999) and second, zoning regulations that seek to maximize tax revenues for the city (Knapp *et al.*, 2000).

Hernandez and Simmons (2006) provide a convincing picture of the evolution of this landscape in Canada: there were 5,000 big box stores, 204 power centres, and 100 power nodes around the country. Big-box stores occupy 180 million square feet of space – equivalent to 3,125 football stadiums – and had total annual sales of $50 billion by 2003 (Hernandez & Simmons, 2006). These numbers are significant in two ways: first, they show there are no apparent limits on how expansive retail businesses can be; and, second, they demonstrate that smaller businesses cannot possibly compete with big boxes' economies of scale. 'Power retail's' growing clout in the retail arena can be explained by two factors. The first is the low prices power retail offers to consumers; and the secondis, as the authors put it, the "brutal efficiency of the logistics system" (Hernandez & Simmons, 2006, 467). What is more, the oversupply of parking lots with

the accompanied higher use of private vehicles in these strip malls of big boxes outcompetes downtown areas as well as public transit, which, in turn, increases housing costs and reduces urban density (Shoup, 1999; 1997; Shoup and Pickrell, 1978).

This changing landscape has moved amenities away from cities and into their outskirts, resulting in poorer accessibility (Ewing, 2008 [1994]) and fewer amenities in the city centre (see Grant & Perrot, 2009). This decline in amenities in urban agglomerations has multiple effects. Economically, a lack of amenities makes a city inefficient, as people do not find the city appealing and chose instead to move to the suburbs (Clark *et al*., 2002). A lack of amenities leads to a decrease in consumer spending, housing prices, and tax revenue from businesses. A decline in amenities in urban core areas also means that the city is less sustainable and encourages people to travel further distances and emit higher amounts of carbon dioxide to reach amenities in the outskirts and suburbs (Batty *et al.*, 2003; Ewing, 2008 [1994]). A lack of amenities is also a contributing factor to rising rates of obesity (Shannon, 2014; Walker *et al.*, 2010). Finally, overall quality of life has been shown to be significantly determined by the availability and accessibility to urban amenities, which declines in sprawling cities (Allen, 2015; Filion *et al.*, 2004).

Last but not least, sprawl is inequitable. No group is more affected by the loss of accessible amenities and urban function than pedestrians, and as such, they are central stakeholders in the development and implementation of accessible urban space. For several decades, scholars have called for pedestrian access to be a central dimension in the measurement of urban quality (Talen, 2002a) and recent planning theories, like New

Urbanism (Congress for New Urbanism, 2001), has reprioritized the pedestrian, with various levels of success (Lo, 2009). In sprawling urban forms, distances are too long, rendering non-drivers unable to access amenities, as they cannot cover the same spatio-temporal scales that cars do (see Sheller & Urry, 2000). Disinvestment in public transit has made matters worse, drastically reducing the mobility of affected residents. Cities are to be liveable for all, not just a few, and this includes people with distinct mobility needs.

Critics of compactness tend to forget about the needs of non-drivers. In their ideal city, everyone drives. But more drivers create more congestion and require more infrastructure. Alternative modes of transport do not require as many subsidies and create much less congestion. Accepting this reality and the shortcomings of sprawl has awakened an increasing number of cities in Canada and the US, which are turning their attention back to the city centre, where livability (e.g. live, work and play) and sustainability are possible. Inner cities have recently been the target for increasing private sector investment (Ley, 1996; Montgomery, 2010, O'Connell 2017a; 2017b; Schwartz 2016) and more people are jumping back on their bikes, feet and transit. A compact and livable city is slowly transitioning from the ideal to the real.

3.3. Realizing the ideal city

Can equitable accessibility be restored in the North American sprawling city? Can visible minorities access amenities in inner-cities? Can women and children reach the facility they are looking for without having to drive? There is a growing consensus that cities need to protect their cores and built up, not out. The public sector is investing back

in the city, especially through transportation projects like light rail and infilling (e.g. the State of Connecticut, the Province of Ontario) in order to increase access for suburban dwellers to jobs in the major city centres and concentrate residential and commercial development (Associated Press, 2017; Ontario Ministry of Municipal Affairs and Housing, 2009).

This trend may be a result of the disappearance of suburban jobs due to the collapse of brick and mortar retailers and shopping malls (Abrams & Gebeloff, 2017; Kurutz, 2017) and the shift of larger multinational companies (e.g. Nike) away from suburban regions and toward talent rich (and consumer-laden) cities (Maidenberg, 2017). Municipalities are also increasing access to, and encouraging the use of, alternative modes of transportation (see for instance: Tugend, 2017; Hu, 2017). Pressure on the housing market in cities such as San Francisco and Vancouver are signs that more people want to live in cities, and when older residents do not want higher densities due to so-called NYMBISM, the state government is stepping up to fight against it (Nagourney & Dougherty, 2017).

But the trend towards intensification may also be a result of municipalities realizing that integrated and inclusive neighbourhoods improve cities' liveability. Much of planning thought is focused on the neighbourhood as the starting point to create a liveable city. In fact, indicators of QOL are often studied at this level since it is assumed that the place where one immediately dwells and lives, with certain objective and subjective features, frames and influences an individual's everyday life (Marans & Stimson, 2011). In recent decades, a dearth of research on neighbourhood wellbeing,

especially by geographers and urban sociologists, has increasingly focused on the neighbourhood as the central scale of analysis for designing and building the ideal liveable city (Altschuler *et al.*, 2004).

The focus on neighbourhoods as units is now instrumental in contemporary urban planning practice (Marans & Stimson, 2011). Traditional neighbourhood (TN) design and the New Urbanist (NU) movement of the 1990s are clear examples of the shifts in planning philosophy from the modernist large-scale grand developments to the neighbourhood scale. Across the global north, NU developments claim to offer solutions to conventional suburban planning, and position neighbourhoods as 'self-contained' spaces that fulfil peoples' daily needs (e.g. live, work and play) without having to travel long distances (Duany *et al.*, 2000; Lund, 2003).

While many planning scholars and practitioners have supported TN design, opponents point to a number of projects that fall short of attaining many of the design ideals and goals (Ford, 1999). One consistent failure is the lack of social diversity (Lund, 2003; Grant, 2002). This may be explained by the fact that most of NU developments are limited to suburban projects with a majority of high-income earners, rather than revitalization initiatives in downtown, where the majority of visible minorities, seniors, singles and families without children dwell.

A second failure is that the push for densification and compactness, such as the so-called 'Vancouverism,' has often led to higher housing price inflation and socio-spatial polarization, decreasing access to services for some demographic groups (Ley &

Lynch, 2012; Rappaport, 2008; Kaido, 2005). In fact, relocations to more affordable suburban developments are still common.

Although cookie-cutter planning guidelines might not work everywhere, a few principles from NU are useful in imagining the form of an accessible city, and that must be a pedestrian-friendly city and 'self-contained' neighbourhoods that fulfil peoples' daily needs (e.g. live, work and play) without having to travel long distances (Duany *et al.*, 2000; Lund, 2003). According to the Congress for New Urbanism, a traditional neighbourhood should be built based on six fundamental rules:

1. A clear *central area*, with a healthy mix of activities
2. *Five-minute walk* radius from the household to amenities
3. A continuous and walkable *street network*
4. *Narrow* human-scaled streets, that are safe for the pedestrian regardless of their age or physical condition
5. *Mixed use* in terms of building form and function
6. *Public commons* that are elevated and promoted for civic use

(adapted from, Duany *et al.* 2000, p. 15-16)

Additional guidelines from scholars (Ewing *et al.*, 2006: 622) list a number of design qualities that a neighbourhood and a city must have to be pedestrian-friendly:

1. Imageability: a quality of a place that captures the pedestrian's attention
2. Legibility: the ease with which pedestrians can orient themselves, aided by reference points and informational signs
3. Enclosure: "the degree to which streets and other public spaces are visually defined by buildings, walls, trees, and other elements" (
4. Human scale: the size of urban elements match the size and proportions of humans
5. Transparency: "the degree to which people can see or perceive [human activity] beyond the edge of a street or other public space"
6. Linkage: "the physical and visual connections from building to street, building to building, space to space, or one side of the street to the other which tend to unify disparate elements"
7. Complexity: "the visual richness of place"
8. Coherence: "a sense of visual order"

9. Tidiness: “the condition and cleanliness of a place”

In short, the most contemporary urban planning theories are increasingly focusing their attention on the neighbourhood as unit of imagination and design, because that is precisely the scale at which urbanites experience the city on a daily basis. These qualities of a self-contained and liveable neighbourhood are not just well-thought ideals of a progressive imaginary, but can be easily found in cities around the world, such as those in Europe, Japan, and Latin America.

Among the many features of a liveable and compact urban form, I turn my focus on the literature of mixed-use in the following section. In my analysis, I use this knowledge to try to explain differences in accessibility between distinct urban forms in the City of St. John’s.

3.3.1. Mixed-use: definitions, impacts on access, and challenges towards implementation

Mixed use development has gained popularity over the years and is one of the more pressing issues that Jane Jacobs (1961) discussed in her seminal book, *The Death and Life of Great American Cities.* As she explained, “cities need ‘a most intricate and close-grained diversity of uses that give each other constant mutual support, both economically and socially’” (Jacobs, 1961).

Adding to spatial expansion and scattered low-density development, non-compact developments are characterised by a lack of, or low levels of, mixing of building forms

and land uses (Grant 2002; Galster *et al.* 2001). Land use is the pattern in which activities are distributed spatially, in terms of their location, density and diversity (Handy *et al.* 2002). In sprawling cities, users often have to pass by large plots of land to get from one point to another due to segregated land uses (Ewing 1997). In addition, most activities of one or two types are concentrated on a single commercial strip (e.g. retail, car dealerships and professional services are three common examples), with nearby residential neighbourhoods devoid of any commercial activity. Applying mixed use in North American cities has been made a challenging endeavour for planners since development subsidies, land regulations, car ownership, and consumer preference has consistently favoured low density approaches (Ewing 2008 [1994]). To be sure, the planning contexts in most cities are typically a complex mix of these development factors. Scholars have weighed in and examined these challenges both quantitatively and qualitatively using specific case studies. Two Canadian scholars who have done extensive work on the challenges of mixed-use development are Jill Grant (2009; 2002; 2001) and Pierre Filion (2001; Filion *et al.* 1999). Both scholars have written broadly on the limits to mixing commercial and residential land uses, including constraints originating from market forces, government decisions, and consumer behaviour. One important conclusion is that the typical challenges to mixed land use are local, 'cookie-cutter' guidelines such as those advocated by New Urbanism (NU) and Sustainable Development (SD), which are not always entirely applicable and, thus, are not 'silver bullets' to the problems of sprawl.

Duplicating intensification policies, such as NU, SD or Smart Growth, is challenging in North America in part due to the wide gaps in planning cultures among

cities and regions in Canada and the U.S.). In addition, these cities present diverse geographic and social contexts, which explains the distinct levels of intensification of the four largest CMAs in Canada (Filion *et al.*, 2010). For instance, although there is ongoing and planned intensification and densification in Vancouver (Quastel *et al.*, 2012) and, more recently, southern Ontario (Ontario Ministry of Municipal Affairs and Housing, 2009), cities like Montreal and Ottawa are experiencing the exact opposite trend of regional suburbanization (Fillion *et al.*, 2010).

The first signs of segregated land use in North America began in the beginning of the 20th century, as older cities became heavily industrialized and municipalities acted on safety concerns (Grant, 2002). Most contemporary planning schools today however, advocate for mixed uses. Despite that reversal in thinking about cities, single-use development still prevails remains the norm due to the development contexts mentioned above.

First, subsidies and infrastructure for car travel not only encourage driving, but also directly encourage separated land uses: vehicle owners can live, work and play in completely separate areas in the city. The total costs of car ownership are subsidized from the maintenance and construction of highways to parking and air pollution (Shoup, 1999; Ewing, 2008 [1994]; 1997). Second, single-family housing and outlying development are subsidized through the tax-code and utility rates, costs covered not only by suburbanites but also by urban dwellers. Third, consumer preference for single-family detached houses encourages the development and concentration of 'residential-only' suburban developments. When it comes to preference for mixed- and single-use areas, people are

evenly divided (Bookout 1992; Shlay 1986, as cited in Ewing 1997). Overall, however, people prefer to live in areas with higher accessibility, such as in compact centers and mixed neighbourhoods (Ewing 1997).

Grant (2002) finds three distinct conceptualizations of mixed use and two streams of mixed-use thinking. The first type concerns the *intensity* of land uses, by mixing the forms and tenures of buildings in any given land use. This may help achieve higher levels of social mixing in neighbourhoods. The second type regards the *diversity* of land uses, by mixing compatible uses, such as commercial and residential. The third type concerns the integration of segregated uses, by eliminating buffers in between land uses, such as industrial and residential. Generally, planners, planning departments and planning advocates have a preference for mixed-use and seek to amend bylaws to encourage combinations of land uses (Grant, 2002). They tend to align themselves with new urbanist principles, traditional neighbourhood design (TND) and transit-oriented development (TOD) (Grant 2002). TND advocates for "intensification and mixing compatible uses at a fine grain" (Grant 2002, 73) while TOD advocates for nodes around transit stations and development around those nodes on a density gradient.

Since the 1980s, mixed-use in Canada has gained traction among planning circles and governments at various levels and is especially important in areas where sustainability is a key feature in provincial and urban policy (e.g. Places to Grow legislation by the Government of Ontario) (Grant, 2009; 2002). Planners continue to embrace the principles of NU, SG, and SD, and are consistently adjusting plans to integrate new ideas in an attempt to reverse decades of suburban expansion (Grant &

Perrot, 2009; Grant, 2002). Projects in downtown Toronto and Vancouver have proved successful, where planners and city councils increased densities, combined land uses and expanded public transit (Punter, 2006). For instance, the St. Lawrence neighbourhood in Toronto became a successful example of urban revitalization with mixed-use (see: Hulchanski, 1984). Cabbagetown and the Toronto waterfront soon followed, as well as other Canadian cities, like Vancouver (Grant, 2002). Worldwide, waterfront and warehouse districts made a comeback thanks to mixed development (e.g. Puerto Madero in Buenos Aires, London Docklands, Battery Park in New York City, the Brooklyn riverfront, and the Copenhagen harbour). However, in most other cities in North America (Schneider and Woodcock, 2008; Broadway, 1992), especially in smaller urban centres, growth has continued to occur in the suburbs (Filion *et al.*, 2004).

Therefore, despite efforts to make changes to zoning plans to revive downtowns and transform suburbs through mixed use, success has been limited (Grant, 2001). The inability of planners to find consensus among the many actors involved in city-making has been a major reason for the failure of mixed-use projects. Residents, business owners, developers and, in some cases, city councillors and some planners resist mixing compatible uses (see Grant & Perrot, 2009; Grant, 2001). In a study of the Burnside Industrial Park in the Halifax Regional Municipality, Grant (2001) found that commercial owners have a disdain towards residential development. In particular, a number of owners claim the area is uncertain and risky for business, a potential blow to their tax base, and too polluted to be safe for residential living. Households, on the other hand, resist mixing with other land uses due to a fear towards changes in the physical and social make-up of

their neighbourhood, loss of open space and higher densities, pollution in the case of industrial uses, and a reduction in the land value (Grant, 2009; Fillion *et al.*, 1999).

In another study on NU mixed-use projects in three Canadian cities (Mckenzie Town in Calgary, Cornell in Markham and Surrey), Grant (2009; 2002) interviewed actors involved to determine the reasons for gaps in implementation of mixed-use. Responses showed a lack of compromise from developers, whose main objective is to increase profits, and from planners driven by ideological principles. Developers argued that consumers look for environments that enable privacy and vehicle ownership. Within city administrations, engineering departments were on the side of developers, resisting planners' pursuit of pedestrian-friendly communities, deeming streets as traffic and emergency vehicle channels rather than public and social spaces. In Markham, planners complained of a lack of fiscal tools (e.g. budget constrains from the provincial government), resistance from residents when trying to increase affordable housing, and businesses that preferred big boxes rather than neotraditional stores. In conclusion, successful projects showed stronger agreements between actors, especially support for planners coming from councillors. Even then, a few developers in Canada have consolidated enough power to be able to sway councils their way (Grant, 2009). And despite proving successful in many cases, once these revitalization projects attract residents, residential developments become dominant over commercial ones over time and mix-use fails years later (Wetzel 1999; Zukin 1989; as cited in Grant 2001).

In a study on three suburban mixed-use centres in the Greater Toronto Area (GTA), Filion (2001) finds that mixed-use has been somewhat successful, although car

dependency and low densities remain. Across the study sites, North York Centre, Scarborough Centre and Mississauga, the intention of planners is to facilitate mixed-use development, combining business, workplaces and residential buildings, as well as alternative modes of transportation and walkable environments. Filion found that North York successfully integrated multi-use complexes, while land uses in the two other centres remained segregated, but less so than the majority of suburban areas in the GTA. The reason why they failed to integrate land uses to a higher degree may include the level of land specialization, the footprint of car-supportive infrastructure, low building density and the space between streets and building facades. These factors make environments less pedestrian-friendly, incentivizing the use of the car and enabling residents to cover larger distances to access services and facilities.

3.4. A brief conclusion to the literature review

While urban form depends on a variety of factors and on the local context in question, this review has shed light on a number of reasons in the literature as to why cities are better off providing accessible amenities and inclusive urban design to urbanites. Cities exist for a reason – they have a unique advantage over other types of settlement geographies in that they bring people and activity together. For a city to attract people, it must offer jobs, services and places that fulfill daily needs and improve one's wellbeing. One of the major obstacles in returning to older urban forms is a culture of material accumulation that rewards individualism over the common good. This individualism is reflected on people's mobilities and choices of residence: in solitude and far from where

people cluster. NYMBYISM is a direct cause of that culture. Pedestrians and other disadvantaged groups must fight to preserve their right to the city, participating in public life, reinforcing their right to public amenities and spaces, and raising their voices at the planning table, so people with power do not have the last say in terms of people's access to the city.

As with many cities in Canada, the city of St. John's offers a good example of a built environment that reflects a shift away from bridging form and function. A simple map of the city shows a street network featuring a high ratio of cul-de-sacs and dead ends, disconnected wide streets, and intersections unsafe to cross. Amenities, on the other hand, are clustered around commercial highways and strip malls built for car access, and many of these clusters lack diversity in their offerings – mainly big box retail and fast food chains. In the following chapters, I explain the methodology used to analyse accessibility in St. John's, to evaluate equality and equity in access to certain types of amenities and how urban form impacts accessibility.

Chapter 4 Methodology

At the core of evaluating accessibility is its measurement, quantification and qualification. This chapter briefly addresses the methodological literature regarding access, and, explains the methodological concepts and operations that this study uses to quantify and qualify accessibility in the St. John's CMA.

4.1. Operationalizing accessibility

Urban accessibility has been studied for decades as one of the most important dimensions of cities, considered both a factor of growth and quality of life (Smoyer-Tomic *et al.*, 2004; Handy and Niemeier, 1997; Dalvi and Martin, 1976). As urban scholarship evolved from positivist towards post-positivist traditions and to more comprehensive frameworks of theory and practice, conceptualizations of accessibility evolved as well. Following this distinction, there are two noticeably contrasting definitions of accessibility: the first considers accessibility as a quantifiable measure; the second considers accessibility qualitatively, as part of a larger social reality and concerned with whether cities are equitable and inclusive.

This thesis uses both dimensions of accessibility by quantifying and qualifying accessibility to six types of amenities in the St. John's CMA. In particular, I am concerned here with counting facilities and services via three coverage criteria, measuring distances to services via both Euclidean and network distances and using the average of those two sets of calculations as well as demographic data to assess need-

based accessibility. A last step in my assessment involves evaluating the relationship between urban form and accessibility through a series of urban form metrics.

Before the 1960s, much of the literature that addressed accessibility consisted of studies on the form of the city or on urban population, which offered highly aggregated measures of accessibility (Hansen, 1959). One such measure was the distance of an origin point to the centre of the city. A second measurement was aggregate travel, understood as the sum of travel distances by every person travelling to a certain area(s). Other measurements were based on calculations of proximities of certain areas to the residential population and on potential interactions between people. Subsequent studies (Apparicio *et al.*, 2008; Hewko *et al.*, 2002) have attempted to disaggregate accessibility measures to make them more precise. Presently, accessibility studies are conducted at the census subdivision level, and when local data is available, such as city-wide or metropolitan surveys and census, data can be analysed at even smaller scales.

One of the first studies offering a more specific operational definition of accessibility was Ingram (1971), who advanced two definitions: i) integral accessibility, or "the degree of interconnection for a given point with all other points on the same surface" (Dalvi and Martin, 1976, p. 18); ii) relative accessibility, or "the degree to which two places (or points) on the same surface are connected" (Dalvi and Martin, 1976, p.18). These are expressed by Dalvi and Martin (1976, p. 18) as:

$$A_i = \sum_{j=1}^{n} a_{ij}$$

where A_i=integral accessibility at the *i*th point; a_{ij} = relative accessibility of point *j* at *i*

Other studies claim that accessibility is the *potential* of opportunities for interaction (Handy and Neimeier, 1997; Hansen, 1959) and, more specifically, as the "measurement of the spatial distribution of an activity [(opportunities for interaction)] adjusted for the ability and desire of people or firms to overcome spatial separation" (Hansen, 1959, p. 4). This definition involves two principal elements of accessibility: transportation (or impedance) and activity (or attraction) (Handy and Neimeier, 1997). Transportation is often measured by travel distance, time or cost, while activity is measured by the number and location of different activities, such as facilities, services, spaces and places (Handy and Neimeier, 1997). The measurement of these two elements constitutes the operationalization of accessibility. Different studies have used a range of methods, from extremely simple to more complex calculations, but it is clear from the literature that a triangulation approach which combines various measurements yields more accurate results.

The spatial distribution of an activity can be quantified by simply counting the number of destinations within a geographic unit. Handy and Neimeier defines this as the 'container' approach; Talen and Anselin (1998) name it the 'coverage' method; Pirie (1979) names it 'cumulative-opportunity measure' (Pirie, 1979, p. 301; see also: Pasch *et al.*, 2009; Sharkey *et al.*, 2009; Smoyer-Tomic *et al.*, 2008; Apparicio *et al.*, 2007; and Smoyer-Tomic *et al.*, 2004). In this research, four coverage criteria are used to calculate

cumulative opportunities for interaction. The first coverage criterion (CCI) counts the number of facilities within the boundaries of a dissemination area. The second criterion (CCII) calculates the total number of amenities within a 500-m buffer area and the third criterion (CCIII) counts facilities within a 500-m service area. Service areas commonly use the facility itself as point of origin and measure the extension of an area that is *serviced* by the amenity, along the street network (for studies using this method, see: Larsen and Gilliland, 2008; Cervigni *et al.* 2008; Oh and Jeong 2007; and Nicholls, 2001). In this study, I generate service areas with the DA centroid as point of origin, in order to count amenities within a 500-m area using the street network. This is different from the 500-m buffer area in that the extension is not a circle with a straight 500m line, but it is rather an irregular area shaped by the street network. The fourth and final criterion (CCIV) is the average of the first three, which is used as a final method to evaluate equity in accessibility.

Another method used in parallel with the coverage approach is the minimum distance approach, by which I calculate the distance to the closest amenity from a point of origin. This allows me to discern with more accuracy how accessible an amenity is. This study uses both Euclidean – straight line – and network – along streets – distances (for studies using minimum distance criteria, see Shah *et al.*, 2016; McKenzie, 2014; Larsen & Gilliland, 2008; Apparicio *et al.*, 2004; and Nicholls, 2001).

The four coverage criteria and the two minimum distance methods measure the potential for interaction based on the number of destinations and the distance to them, and these can be easily quantified with the right data. Some other studies, however, have

become more interested in the *actual*, rather than *potential*, use of accessibility as a measure of access (Morris *et al.*, 1979). However, research studying potential accessibility depends on different types of methodologies, such as surveys and observation. Access as opportunities for interaction is the most common definition used because it is also the most readily available for analysis, using spatial and census data.

4.2. Data and scale of analysis

To analyse accessibility to amenities in St. John's, NL, this research uses census and business microdata at the census dissemination area (DA) level across the St. John's CMA in 2006. This section describes the data, scales and computing tools used in this research.

Census data for this research is primarily drawn from Statistics Canada's Census of Population program, specifically, the 2006 Census. Data from the 2011 Census is not considered given the unreliability of the census' voluntary form (Hulchanski *et al.* 2013) and the 2016 Census is not used given that 2016 data was not completely released at the time of this analysis.

The census data is examined at the DA level. A DA is defined as a "small, relatively stable geographic unit composed of one or more adjacent dissemination blocks [with a population of 400 to 700 persons]. It is the smallest standard geographic area for which all census data are disseminated" (Statistics Canada, 2011). As the smallest geographic unit in the 2006 census, it is the most precise and least aggregated unit of measurement.

Data on urban amenities is retrieved from a special micro dataset that comprises all business establishments in the St. John's CMA. The database houses datasets of registries of private and public establishments in Atlantic Canada (InfoCanada®[4]), covering establishments operating across the region. The data is drawn from the 2010 InfoCanada® database (91,925 entries). The InfoCanada® database contains entries for all amenities analysed in this research and the 2010 dataset is used in parallel to the 2006 Census. Research on amenities is complemented with internet searches and geocoding with ArcGIS when information from the InfoCanada® datasets is deemed insufficient.

4.2.1. Preparation of data

Census data was prepared using Beyond 20/20® Professional Browser 7.0 (Beyond 20/20, Ottawa, Canada), downloaded from the Statistics Canada website. Total population numbers were extracted from all the 318 dissemination areas within the boundaries of the St. John's CMA for further analysis.

Business data was prepared using STATA® 12.1 (StataCorp, College Station, TX, USA) and Microsoft® Office® Excel® 2013 (Microsoft Corporation, Redmond, WA, USA). Six categories of establishments (i.e. grocery stores, schools, recreational facilities, health facilities, and nursing and childcare services) for the St. John's CMA were extracted from the InfoCanada® database using their North American Industry

[4] Information about this database is available at https://infogroup.infocanada.ca/sales-leads-and-mailing-lists/business-lists.

Classification System (NAICS) number, provided by the database (the NAICS categories were consulted online)[5].

Census and amenity data are integrated into a Geographic Information System, using ArcGIS 10.3.1® (ESRI®[6]). ArcGIS, in conjunction with Excel, are the two primary computing tools for this research. The former is used to conduct spatial analysis, including evaluating the spatial distribution of establishments, generating origin points, measuring distances, generating service areas, counting facilities and generating maps; while the latter is used for statistical analyses.

4.2.2. Location: St. John's, Newfoundland

St. John's, NL, capital of Newfoundland and Labrador and a metropolitan area of significant importance was selected for this study. More information on St. John's and the reasons for this choice are offered in Chapter 5.

4.3. Measuring accessibility: Spatial and statistical analysis

For this study, accessibility is measured for six types of amenities across the St. John's CMA, by computing availability, mix, and distance to amenities, and comparing them with demographic data and urban form. This research uses a combination of criteria from

[5] NAICS is a classification system that creates a number for each economic activity, such as retail stores or museums (Statistics Canada, 2017). More information about NAICS is available at http://www.statcan.gc.ca/eng/subjects/standard/naics/2012/introduction.
[6] Information about ArcGIS is available at https://www.esri.com/arcgis/about-arcgis.

various studies on accessibility to paint a more complete picture of the reality on the ground. The measures used here are computed in each DA and are described as follows:

A: Quantification Method

1. Four coverage criteria (CCI, CCII, CCIII, CCIV):

    a. The number of *all*, and *each type* of, amenities and the mix of all amenities within boundaries of each DA (CCI)
    b. The number of amenities (total and by type) and mix of all amenities within a buffer area of 500m using Euclidean distance (CCII)
    c. The number of amenities (total and by type) and mix of all amenities within a service area of 500m using network distance (CCIII)
    d. The average of CCI, CCII, and CCIII (CCIV)

2. Mean distance and minimum distance:

    a. The minimum distance from the centroid to the closest amenity using Euclidean distance for each type of amenity DA
    b. The minimum distance from the centroid to the closest amenity using network distance for each type of amenity by DA
    c. The average of the two distance measures

3. Need-based accessibility (using average coverage)

    a. Mean and median population in the CMA and by DA
    b. Percentage of demographic groups in the CMA
    c. Amenities by ranges of population (total amenities and by type)
    d. Amenities per capita (total amenities and by type)
    e. Amenities (total and by type) by ranges of population for each demographic group
    f. Amenities per capita for each demographic group (total amenities and by type)

B: Qualification methods

A comparison is undertaken between accessibility values in pre-war and post-war urban St. John's in order to explore the existence of relationships between urban form and accessibility in the metropolitan area. This comparison is done using a series of metrics,

including average minimum distance to amenities and schools; land uses; percentage of single-detached houses; building density; population density; and road length.

4.3.1. Setting a maximum distance

Maximum distance for this study is set to a 500m radius from the point of origin. This is in agreement with traffic manuals and studies that show that the average distance that can be covered within 10 minutes of walking is between 500m and 800m, at walking speeds between 0.91 m/s and 1.39 m/s (Carey, 2005). Given St. John's topography with steep streets and in an effort to equalize walking speeds across demographic groups, 500 is an appropriate baseline for a 10m walk.

4.3.2. Points of origin and destination

An important aspect of measuring distance is to specify the origin and the destination. The origin point in accessibility evaluations refers to the point of departure for a person travelling to a destination. Given that it would be an insurmountable task to measure distances from each household to the destination in question, a centroid – the unweighted geometric central point on an XY plane – of a geographic unit is used as the common origin point for all trips originating in that geographic unit (Smoyer-Tomic *et al*., 2004; Talen & Anselin, 1998). The use of a centroid has limitations in that it aggregates error (Smoyer-Tomic *et al.*, 2004). Within a geographic unit, the centroid acts as a single origin point when, in reality, there are as many origins as there are people. The higher the

aggregation of data, such as that of a national census, the less specific the centroid is and the more aggregation error occurs.

4.3.3. Accessibility measurement approaches

Levels of accessibility, quantitatively speaking, depend in great part on the measurement used (Smoyer-Tomic *et al.*, 2004; Talen, 1998; Talen & Anselin, 1998). A combination of various approaches or criteria can result in a more accurate analysis, where one measurement can reveal what a second one may not (Apparicio *et al.*, 2007; Handy & Niemeier 1997). In this study, three types of measurements are applied to assess accessibility to amenities in the St. John's CMA. The measurements (i.e. coverage criterion I, II, III and IV) and sub-measurements are described in following subsections.

4.3.3.1. Container approach (Four coverage criteria)

The container approach is the most common type of measurement of accessibility (Apparicio *et al.*, 2007; Smoyer-Tomic *et al.*, 2004; Talen & Anselin, 1998). As mentioned above, it is defined as the "number of facilities or services contained within a given [geographic] unit" (Talen & Anselin, 1998, p. 599). The container approach is rather basic and presents certain limitations. In particular, the approach does not provide information on travel distances to amenities or whether facilities cluster together in one area of the geographic unit. Generally, this approach assumes that the higher the number of amenities, the more accessible the geographic unit.

<u>Amenities within a DA (Coverage criterion I)</u>

The first step to calculate accessibility under this approach is to simply add the total number of amenities of interest to this research within the boundaries for each of the 318 DAs in the CMA, that is, the total count of 6 types of amenities

$$A^1 = \sum a \tag{5.1}$$

where A^1= accessibility measure 1; a = all amenities of six chosen types in the DA.

The second step is to provide separate total counts for each type of amenity (i.e.. number of grocery stores, number of health clinics)

$$A^2 = \sum_{n=1}^{6} a_{t_n} \tag{5.2}$$

where a_t= all amenities within one type

This study not only counts the number of amenities per DA, but it also computes the 'mix' of amenities, that is, the number of *types* of amenities found in a DA. The higher the mix, the more accessible the DA. The mix reveals more information: For example, if DA 1 has 20 amenities in a CMA with an average count of 10 amenities per DA, it may be assumed that DA 1 is generally accessible. However, if most of those amenities are of two types, such as grocery stores and health clinics, the DA is less accessible, relatively speaking, than it was thought to be.

With that said, the third step is to give DAs a number reflecting their amenity mix. The mix of amenities is calculated by attributing a number to each type of amenity (1, 2, 3, 4, 5, 6) indicating the existence of an amenity with the number 1 and the lack of it with a number 0. The 1s and 0s are added together, giving a score 0 to 6, with 6 being the most diverse

$$A^3 = \sum_{n=1}^{6} t_n \quad (5.3)$$

where t_n=type of amenity ($t_n \in [0,6] \in i$)

Amenities within a 500m buffer area (Coverage criterion II)

The fourth step is to generate a buffer area with a radius of 500 m from the DA centroid using the buffer tool in ArcMap and add the number of amenities within that buffer

$$A^4 = \sum a_b \quad (5.4)$$

where a_b= amenities in the buffer area.

The fifth measure is to add amenities by type within the buffer area

$$A^5 = \sum_{n=1}^{6} a_{bt_n} \quad (5.5)$$

where a_{bt} = all amenities for one type within the buffer area; n = (1, 2… 6).

The sixth measure consists on giving DAs a number reflecting their amenity mix within the created buffer area around their centroids

$$A^6 = \sum_{n=1}^{6} t_{b_n} \quad (5.6)$$

where t_b =type of amenity within the buffer area ($t_b \in [0,1] \in i$)[7]

[7] This follows the same method as measure 3. The amenity mix in a DA is calculated by assigning a 0, if there are none amenities of one type, or 1, if there is at least one amenity of that type. Then the 0s and 1s are added together and the final number reflects the mix 'score,' from 0 to 6.

Amenities within service areas (Coverage criterion III)

The 7th step is to generate a service area – an area around a point that measures the number of destinations along the street network – with a radius of 500 m from the DA centroid using the service area tool in the network analyst extension in ArcMap and add the number of amenities within that area

$$A^7=\sum a_s \tag{5.7}$$

where a_s= amenities in the service area.

The 8th measure is to add amenities by type within the service area

$$A^8= \sum_{n=1}^{6} a_{st_n} \tag{5.8}$$

where a_{st} = all amenities for one type within the service area; n = (1, 2… 6).

The 9th measure consists on giving DAs a number reflecting their amenity mix within the created service area around their centroids

$$A^9= \sum_{n=1}^{6} t_{s_n} \tag{5.9}$$

where t_s=type of amenity within the service area ($t_s \in [0,1] \in i$)

Average of three criteria (Coverage criterion IV)

The three criteria are averaged for all amenities, for each type of amenity, and for amenity mix scores.

4.3.3.2. Minimum-distance approach

The minimum distance approach is another common accessibility measurement that calculates the distance one has to travel on a straight path or along the street network to reach the closest amenity from the point of origin. This complements the container approach in adding a distance measure to the evaluation of accessibility. While a container measurement may result in 0 amenities within a DA, a minimum distance shows the distance a person in that DA needs to travel to reach an amenity outside of the DA, which may reveal higher access in adjacent DAs.

Euclidean minimum distance

Under this approach, the 1st measure consist of calculating the Euclidean minimum distance to the closest amenity for each individual DA

$$A^{10} = d_e \tag{5.10}$$

where d_e = minimum distance (Euclidean) from every DA centroid to the closest amenity

The 2nd and 3rd distance measures calculate the mean and median Euclidean minimum distance in the whole CMA

$$A^{11} = \frac{\sum d_e}{n_e} \tag{5.11}$$

where d_e= minimum distance (Euclidean) from every DA centroid to the closest amenity in the CMA and n_e=number of d_e

$$A^{12}=median\ (d_e) \tag{5.12}$$

The 4th and 5th distance calculations generate the mean and median distance (Euclidean) to amenities of each type in the CMA and the DA

$$A^{13}=\frac{\sum d_{t_e}}{n_{t_e}} \tag{5.13}$$

where d_{te}=distance (Euclidean) to amenities of one type; n_{te}=number of d_{te}; ($t \in [1,6]$)

$$A^{14}=median\ (d_{te}) \tag{5.14}$$

Network minimum distance

Under this approach, the 1st measure consist of calculating the network minimum distance to the closest amenity for each individual DA.

$$A^{15}= d_n \tag{5.15}$$

where d_n= network minimum distance from every DA centroid to the closest amenity

The 2nd and 3rd measures calculate the mean and median minimum distance to all amenities in the CMA using network distance.

$$A^{16}=\frac{\sum d_n}{n_n} \tag{5.16}$$

where d_n=all the distances (network) from every centroid to every amenity in the CMA; n_n=number of d_n

$$A^{17}=median\ (d_n) \tag{5.17}$$

The 4th and 5th distance calculations generate the mean and median distance (network) to amenities of each type in the CMA and the DA

$$A^{18}=\frac{\sum d_{t_n}}{n_{t_n}} \quad (5.18)$$

where d_{tn}=distance (network) to amenities of one type; n_{tn}=number of d_{tn}; ($t \in [1,6]$)

$$A^{19}=median\ (d_{tn}) \quad (5.19)$$

Average of two distance measures[8]

The two minimum distance measures are averaged for all amenities and for each type of amenity.

4.4. Accessibility based on need

The previous accessibility measures serve to objectively determine levels of accessibility for the general population, but this may differ significantly among various demographic groups. In this study, I evaluate accessibility for five groups: people aged 0 to 14, senior, low-income residents, drivers, and non-drivers.

Population in CMA and per DA

The 1st need-based measure calculates mean and median population per DA

$$A^{20}=\frac{P_{cma}}{318} \quad (5.20)$$

where P_{cma}= population in the SJCMA and 318 is the number of DAs in the CMA.

[8] I use both Euclidean and network measures because, in my opinion, they complement each other. I offer an explanation for this reasoning in pages 214-215 under Appendices.

Amenities per capita

The 2nd need-based measure calculates amenities per capita in the CMA, using the total amenities calculated under coverage criterion IV, that is the average of the other three coverage criteria

$$A^{21}=\frac{A_{cma}}{P_{cma}} \tag{5.21}$$

where A_{cma}= total amenities in the SJCMA; P_{cma}=population in the CMA.

The 3rd measure calculates amenities per capita by type of amenity.

$$A^{22}=\frac{\sum a_{t_n}}{P_{cma}} \tag{5.22}$$

where a_{tn}= total amenities of one type; P_{cma}=population in the CMA; ($t \in [1,6]$).

The 4th measure calculates amenities per capita by type of amenity and by demographic group.

$$A^{23}=\frac{\sum a_{t_n}}{P_g} \tag{5.23}$$

where a_{tn}= total amenities of one type; P_g=population of one demographic group; ($g \in [1,5]$).

4.5. Analysing the urban form of St. John's

The urban form of a city can shape accessibility in a significant way (Talen 2002; Ewing 2008 [1994]; 1997; Lynch 1984). As part of my discussion on the accessibility findings, I compare the urban form of pre-war St. John's and post-war St. John's (urban area). For

this purpose, I calculate a series of metrics, which include the area of pre and post-war St. John's; the mean distance to amenities and to schools; the percentage of population working outside of their census subdivision of residence; the area percentage of different land uses; population density; average total amenities and average mix score; average road length; average building density; and percentage of single-detached houses.

This analysis is only done within the boundaries of the City of St. John's as this municipality is the largest and oldest incorporated city in the wider St. John's CMA. Its municipal status since 1888 and incorporation as a city in 1921 predates Mount Pearl's city status since 1988, the second largest municipality in Newfoundland and Labrador (City of Mount Pearl, 2016; City of St. John's, n.d.). This difference signifies that the City of St. John's shows starker differences in urban development (pre- and post-WWII) as compared to other municipalities, allowing this study to evaluate accessibility in different historical stages of development.

4.5.1. Land-use mix

Data to calculate land-use mix was obtained from the Chief Planner at the City of St. John's Planning and Engineering Department. Percentages of different land uses in the study area are calculated as

$$A^{24}=\frac{\sum land_{prwDA_n}}{\sum A_{prwDA}} \tag{4.24}$$

where $land_{prwDAn}$= area for one type of land use in a pre-war St. John's DA, A_{prwDA}=area of one DA in pre-war St. John's; ($n \in [1,5]$).

$$A^{25}=\frac{\sum land_{ptwDA_n}}{\sum A_{ptwDA}} \quad (4.25)$$

where $land_{ptwDAn}$= area for one type of land use in a post-war St. John's DA, A_{pstDA}=area of one DA in post-war St. John's; ($n \in [1,5]$).

4.5.2. Population density

Data to calculate population density is taken from the 2006 Census. Population density for the two study areas is calculated by dividing population by total area minus open space and rural areas.

4.5.3. Average road link length

Average road link length was calculated by adding the individual links in a road and dividing them by the number of links.

4.5.4. Building density

Information on total number of private dwellings was obtained from the 2006 Census. Building density was calculated by dividing total private dwellings by total area (total area does not include open space or rural land uses). This was done for both pre-war and post-war St. John's.

4.5.5. Single-detached houses

Information on single-detached houses was obtained from the 2006 Census. The percentage of single-detached houses was calculated by dividing the total number of single-detached houses by the total number of private dwellings.

Chapter 5 : Analysis, part I: Is St. John's accessible?

The main goal of this study is to conduct an evaluation of accessibility to various urban amenities for the person on foot and explore whether the St. John's metropolitan region is accessible. With that goal in mind, I evaluate walking accessibility – within a 10-minute or 500-meter walk – to six types of facilities and services in the St. John's Census Metropolitan Area (SJCMA) between 2006 and 2010, including food stores (grocery stores, convenience stores and specialty stores); elementary and secondary schools; recreational facilities and services (i.e. playgrounds, gyms, community centers, entertainment companies/shows); health facilities (i.e. clinics, hospitals, and medical offices), nursing facilities[9] for senior citizens and child care facilities. I conduct this evaluation across the CMA and by census dissemination area.

This chapter is divided into four sections. The first section provides a brief introduction to the geographic context – that is, the St. John's census metropolitan area and its main census agglomerations. The second section begins the analysis of accessibility in the CMA with a calculation of the average of two minimum distance measures – Euclidean and network – between origin points and destinations, and the average of three coverage criteria[10]. The third section analyzes accessibility as a measurement per capita using the average of the three coverage criteria.

[9] Nursing care facilities are, for the most part, places of residence, not ambulatory. They are included here because they need to be accessed at some point. If there were no nursing facilities in a given area, the person seeking this resource would need to travel a long distance to reach them, at whatever stage of their life. Therefore, accessibility and need must be considered when planning for a new nursing care facility.
[10] The two minimum distance measures and three coverage criteria used in this study are described in the Methods chapter and explained in detail in the corresponding Appendices.

5.1. The St. John's metropolis: A suburbanizing region

Located in the Northeast Avalon Peninsula, the St. John's Census Metropolitan Area (SJCMA) and the City of St. John's are the second largest CMA and city in Atlantic Canada, respectively. The City of St. John's is among the oldest cities in North America and second most powerful economic hub in Atlantic Canada. Given the city's age, the fact that strategic urban planning was not part of the city's or metropolitan area's development until recently, and the demographic decline of the last few decades, the City of St John's and the CMA represent an interesting and important case study for analysis (Ibbitson, 2017). Indeed, the city's inner core areas show higher building density, while its contemporary urban profile is arguably suburban, spread out and covering large tracts of land. Much of the city's development lies outside of the downtown area and is non-compact, with many big box commercial strips that cater to the car access. With this in mind, the city is car friendly, and 85% of its population owns a private vehicle. A lack of research in small and medium-sized cities (Bell and Jayne, 2009) and on the urban areas of Atlantic Canada adds significance to this research on St. John's.

The SJCMA is spread across 804.64 km^2, with a population of 181,113 and a population density of 225.1 persons per km^2 (Statistics Canada, 2008). The metropolitan region has consistently grown in population, experiencing a 4.74% increase from 2001 – compared to a 1.45% decline in the province and 5.35% growth in the country (Statistics Canada, 2007; 2002). Furthermore, the metropolitan growth represents close to a 2% growth in the ratio of metro to provincial population, from 34% to 36%, indicating that

the province has increasingly urbanized, even as demographic growth in the province has deaccelerated significantly over the years and is predicted to start shrinking in the near future (Simms & Ward, 2017; Statistics, 2008; 2002). The reason for this is that the metropolitan region has attracted a significant percentage of in-province migration.

Although it has increasingly urbanized, growth in the SJCMA for the last few decades has taken place for the most part in the suburban periphery, outside of the urban core – St. John's and Mount Pearl – in towns like Paradise and Conception Bay South (Table 5.1). This has decreased population densities in the only two cities in the province. With a population of 100,646 in 2006, the City of St. John's has a population density close to that of the CMA. While the city constituted nearly 53% of the metropolitan population in 2006, its demographic share has declined from 56% in 2001. Moreover, the City of Mount Pearl has shown an absolute decline in its population. The spatial expansion and declining densities of the urban core have reinforced sprawling development, lack of accessibility and fiscal precarity.

Table 5.1. Population change in the SJCMA and dominant subdivisions (Statistics Canada, 2008; 2002)

	2006	2001	Change %	Pop. Density per km^2 (2006)	Population% in CMA (2006)
Canada	31,612,897	30,007,094	5.35	3.5	N/a
NL	505,469	512,930	-1.45	1.4	N/a
SJCMA	181,113	172,918	4.74	225.1	100
St. John's	100,646	99,182	1.48	225.6	55.57
CBS	21,966	19,772	11.10	370.6	12.13
Mt. Pearl	24,671	24,964	-1.17	1566.9	13.62
Paradise	12,584	9,598	31.11	430.4	6.95

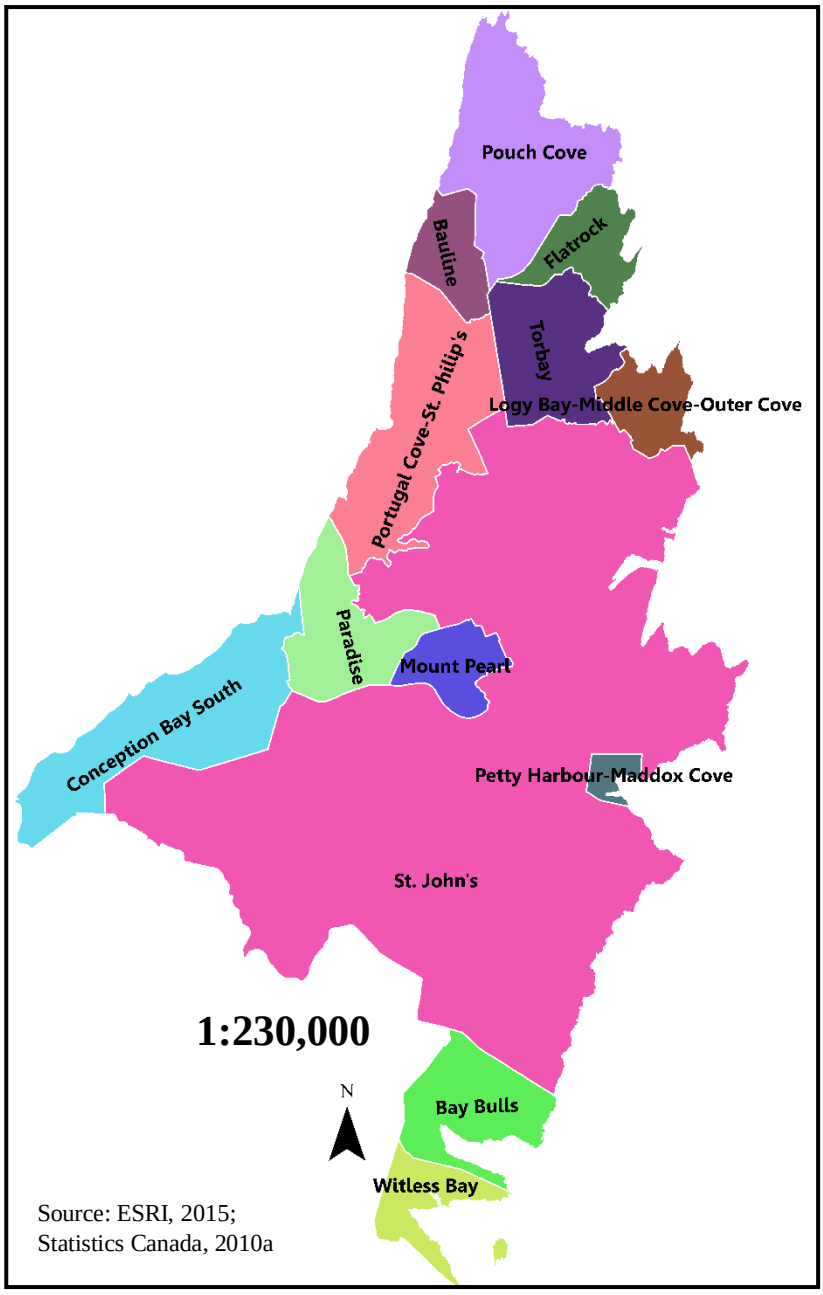


Figure 5.1. Census subdivisions in the SJCMA

Despite its declining population, density and status, the City of St. John's represents a regional powerhouse and the core of the St. John's metropolitan area. An old city that had its beginnings as a fishing economy, St. John's has relied on its harbour for most of its life and it is precisely on the shores of the Atlantic Ocean where urban development began. For the first half of the 20th century, the city remained compact. However, crowding, a lack of affordable housing, and failing infrastructure pushed people away into settlements outside of St. John's, such as Blackhead Rd and Mundy Pond (Collier, 2011b). The first urban expansion into what now is Central St. John's began north of Military Road, with the construction of Circular Road and the neighbourhood of Georgestown (Collier, 2011b). To the west, the city expanded along the Waterford Bridge Road and LaMarchant Road, which today is known as the West End (Collier, 2011b). The rest of the metropolis was, at the time, composed of farmland and undeveloped land.

The city started expanding more rapidly and in a planned fashion during and after the Second World War and the decision to join the Confederation. On one hand, fields outside of the city were used as military bases, expanding the urbanization of the metropolis. On the other hand, upon the return of soldiers and people fleeing war in Europe, pressures on the housing stock in the old city pushed the government to start the planning and construction of North America's largest garden suburb, Churchill Park, spearheaded by the St. John's Housing Corporation (SJHC) (Collier, 2011a). Rising incomes gave local residents purchasing power and a dream to chase a higher quality of life, to which the SJHC responded by building bigger houses. Churchill Park alleviated

the ills affecting the inner city, but simultaneously became the first of many projects leading to the expansion, suburbanization and diffusion of St. John's (Sharpe, 2005). Over the subsequent years, St. John's amalgamated and built more neighbourhoods, including Virginia Park; Wedgewood Park (built in the 1960s and incorporated into St. Johns in 1991) in the east end; Mundy Pond, in the 1960s; the Kenmount Rd. area in the late 1960s; Cowan Heights in the west end in the 1970s and 1980s; and Southlands, Kilbride, and Goulds, in the south, all of which were incorporated into St. John's in 1991 (Collier, 2011b) (Figure 5.2).

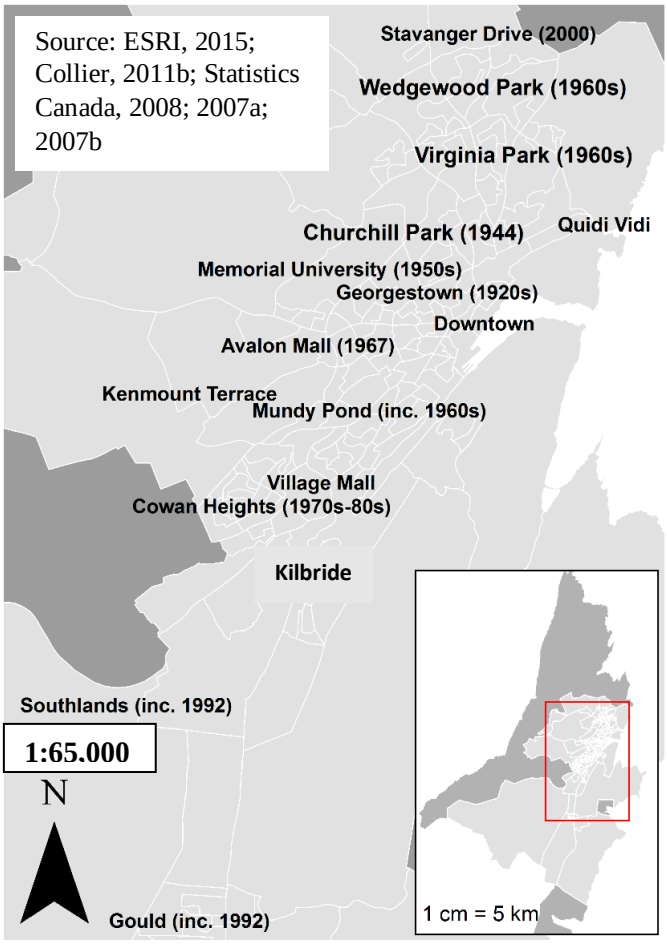


Figure 5.2. Boundary expansion of old St. John's

The increasing spatial growth of St. John's has continued to this day, with one of the largest commercial developments, Stavanger Drive, opening its doors as recently as 2000 (Collins, 2004). This growth is characterized by discontinuous, leapfrog, low-density and single-use development. In other words, sprawl is the main form of urban growth in St. John's, and this form of development has led to an accessibility vacuum in the city, affecting certain demographics more than others. An analysis on accessibility based on a series of measures can better evaluate how well people in the metropolis are serviced in terms of education, health, recreation and food security.

5.2. Accessibility analysis: average minimum distance

In the following section, I present the average of two minimum distance measures and three coverage criteria to explore accessibility in the SJCMA (see Appendix for results for each of the three coverage criteria and the two distance measures). These five measures were averaged with the purpose of using the strength of each measure and make up for their respective biases and shortcomings. The case for using several measures to study accessibility is supported by previous studies, in which authors have used more than one methodology to make up for aggregation error and errors in data collection as well as other biases[11].

My analysis reveals that the SJCMA is, on average, not accessible for the pedestrian. The average minimum distance – a number drawn from averaging Euclidean

[11] More information on studies using accessibility measures is provided in Chapter 4.

and network distances – is 695.55 meters, which is nearly 200 meters further than the standard walking distance of 500 m (Figure 5.3). Specifically, food amenities show the lowest average minimum distance (1046 m) in the CMA followed by health amenities (1231.55 m). This can be explained by the high presence of small convenience stores around the city, given that larger grocery stores tend to consolidate around commercial strip malls. The abundance of health amenities – this includes doctor's offices – can be explained by the higher-than-national average senior population, which requires more care than other age groups. Nursing is by far the service with the highest minimum distance at 2066.74 m, which is concerning given the growing ratio of senior citizens in the metropolis.

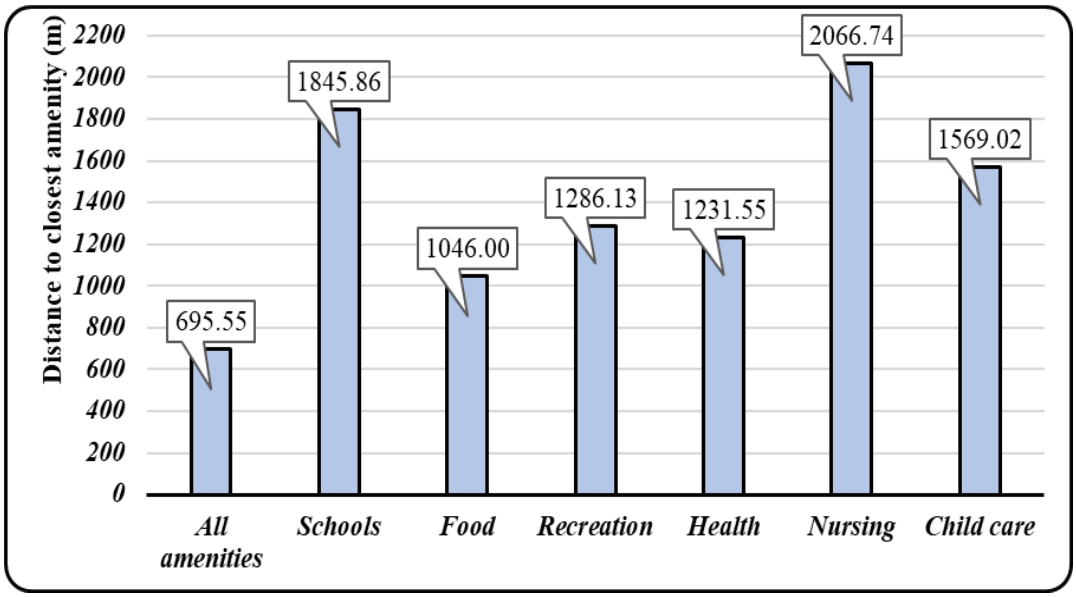


Figure 5.3. Average values of two distance measures by type of amenity, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

It is worth noting that this comprehensive average distance measure does not reflect the fact that distances in many DAs are actually much lower and closer to the gold standard of 500m. This difference is shown in Figure 5.4, where it is made clear that there are more DAs with an average minimum distance under 500m (184 DAs) than there are DAs with minimum distances above 500m (134 DAs). Moreover, the average measure does not reflect the much lower Euclidean distances, whose median is 300.08 meters, well under the 500-m standards[12]. This is explained by the fact that 221 out of 318 dissemination areas in the SJCMA have Euclidean distance values under 500 meters and the average Euclidean minimum distance in those DAs is well under 500m. Therefore, while the mean minimum distance – calculated on the average of the two distance measures – for the whole SJCMA is higher than the maximum walking standard, for many dissemination areas, amenities can be accessed by walking less than 500m.

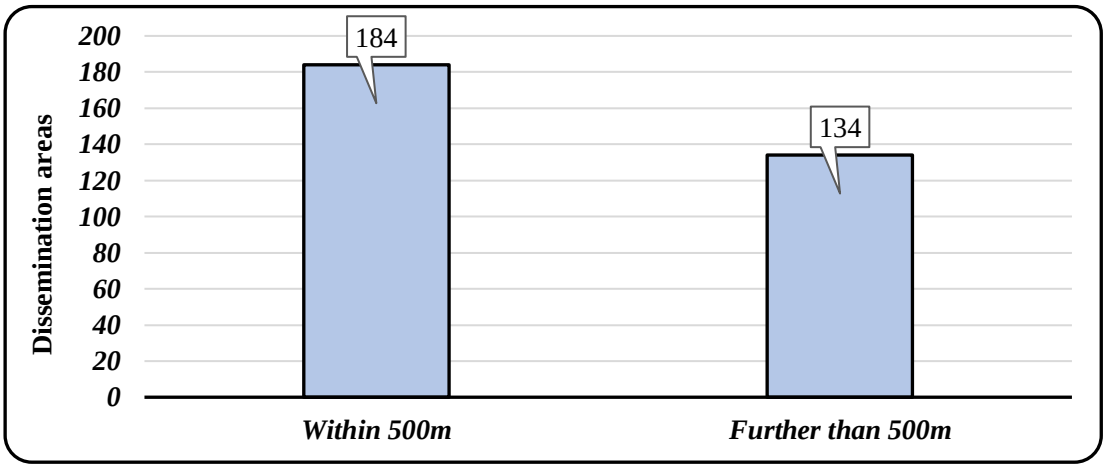


Figure 5.4. Dissemination areas by average minimum distance (500m and further than 500m), SJCMA, 2010

[12] Results for the calculation of Euclidean minimum distances are presented in the Appendices.

Among average minimum distances within 500m, recreational amenities present the lowest average distance, at 206.51 meters (Figure 5.5). Recreational services are abundant in the SJCMA, with anything from performance companies to community centres readily available to the public. Recreational facilities have the additional advantage of showing a lower consolidation rate than other types of services, which tend to concentrate in specific areas. Finally, schools and nursing care facilities are, on average, the furthest from households. A main reason that can explain the longer distance to schools is that these have increasingly consolidated, following the decline in the numbers of children and youth across the province. With a lower number of schools comes a lower accessibility.

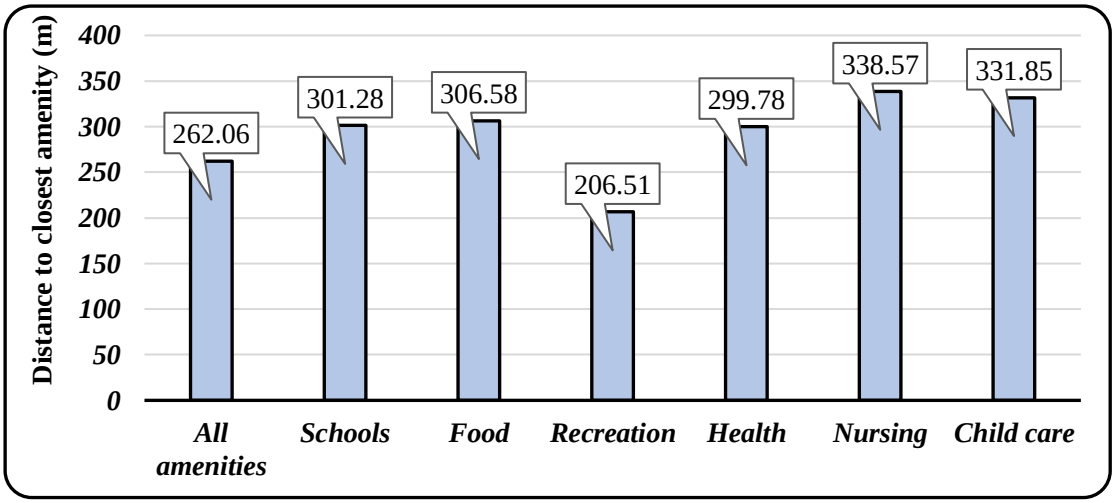


Figure 5.5. Average values of two distance measures within 500m of a centroid, by type of amenity, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

Spatially speaking, minimum distances vary widely across the SJCMA. As can be observed in Figure 5.6, dissemination areas located in the urban core have much lighter colors, corresponding to lower average minimum distances than the rest of the CMA.

Most of the DAs located in the St. John's downtown area have an average minimum distance to their closest amenity of less than 200m. DAs in Central St. John's, as well as those in Mount Pearl, have a mixture of colors, with DAs averaging between 11 and 526 meters of minimum distance. Residents in the rest of the CMA face distances of more than 900 meters to reach the closest service or facility, although there are some exceptions, namely in the towns of CBS and Paradise. This spatial difference between the urban core and towns in the periphery is explained by the higher concentration of amenities in the urban core – in turn, explained by the higher presence of commercial and commercial/residential land uses – than in the suburbs and commuter towns. The central areas of these towns are not as strong or as old as the downtown in St. John's.

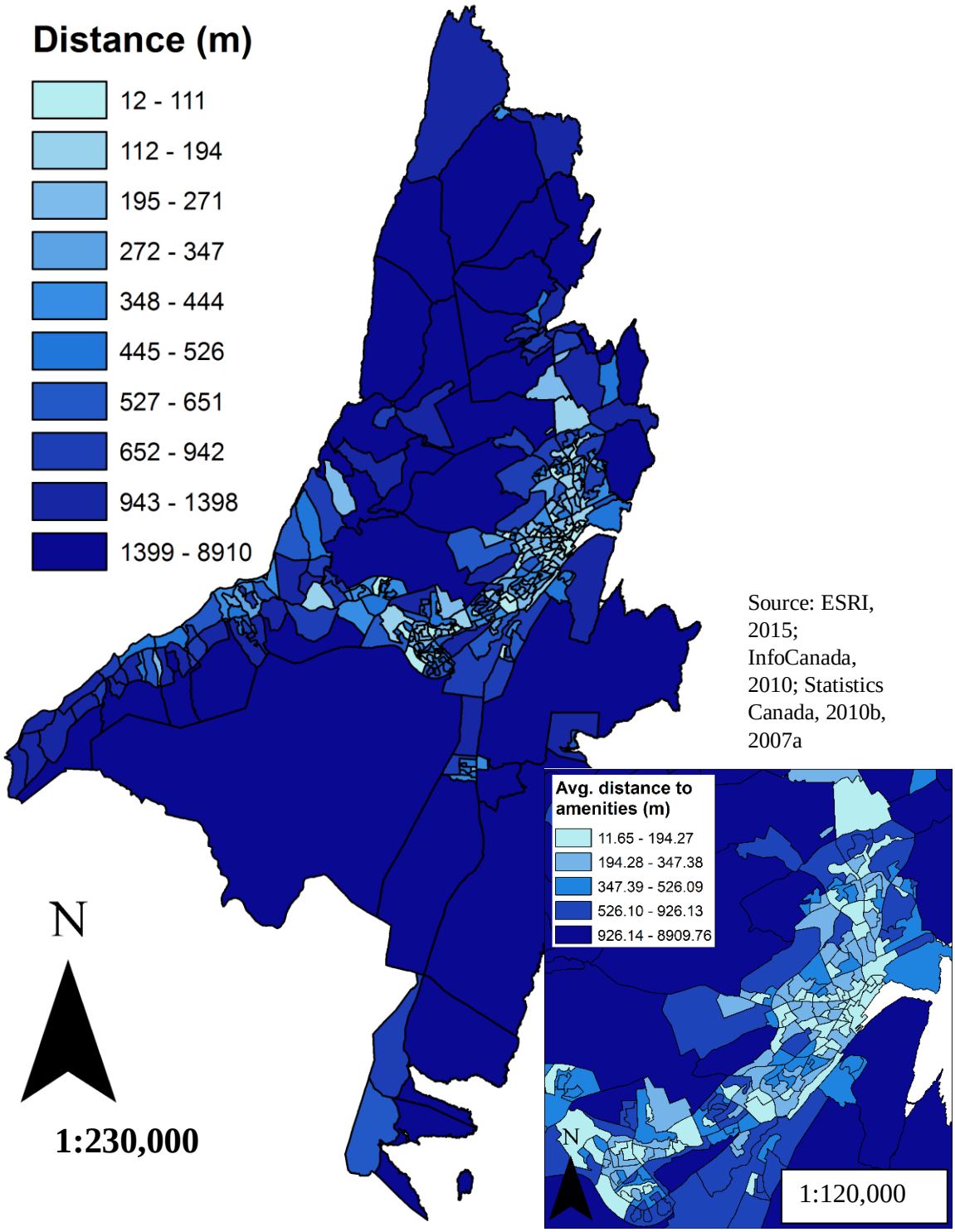


Figure 5.6. Geographic distribution of DAs by average minimum distance to closest amenity, SJCMA and its urban core, 2010

The higher-than-500m minimum distances in the SJCMA to 6 types of amenities is a first indication that the metropolis is not accessible. Furthermore, the spatial distribution of DAs by distance to closest amenities, which shows the closest amenities in the urban core, signifies that, as the population in the region suburbanizes, their accessibility suffers. Hence, there is a higher necessity of private transportation. Those among the 15% or so who do not drive are, thus, at a disadvantage.

However, despite their common use in accessibility studies, minimum distances are not sufficient to determine whether an area is completely accessible or not. Accessibility is more complex than what a distance measure can tell. First, the average minimum distance is much higher than that of many areas of the SJCMA – some areas in the region are more accessible than others. Furthermore, there is an amenity factor – some types of amenities are more accessible than others. In addition, although in many DAs most amenities may be located further than 500m of the centroid, the number of amenities outside of that 500m range may be large enough to offset the longer distances. Finally, some demographic groups enjoy easier access to amenities on foot than others do – different income levels, age structures, and dominant modes of transportation lead to differing levels of accessibility. There is, in other words, a spatial, amenity and demographic inequality. Not only is there a certain inequality in terms of where, what and who, but as urban form enables or constrains accessibility and the 13 municipalities in the SJCMA have various population and building densities, land use mixes, and street networks, accessibility also varies significantly depending on levels of sprawl/compactness.

In order to paint a more complete picture of accessibility in the SJCMA, it is necessary to look more closely at the numbers obtained from the coverage criteria and the demographic data. Coverage methods can account for additional amenities that may be within a 500m range of the centroid and may also show that there are several amenities right outside of the 500m range but are still located in the same DA. Both methods point to stark social-spatial differences, which makes accessibility spatially unequal and inequitable in the SJCMA, and these differences can be explained, at least in part, by the varying degrees of compactness and sprawl.

5.3. Accessibility analysis: average coverage criteria (CCIV)

In this section, I present a fourth coverage criteria (CCIV), which represents the average value for the three coverage criteria, as a second method to evaluate accessibility in the SJCMA. Results for this analysis reveal that, in 2010, residents had walking access to at least one amenity in 274 DAs. Results also show that 232 out of the 318 DAs in the SJCMA (~73%) had under 4.79 amenities, the average metropolitan mean value (Table 5.2). The median, however, is much lower, showing that the majority of DAs in the CMA had walking access to less than 2 amenities.

Table 5.2. Descriptive statistics for average of three coverage criteria (CCIV) (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

	CCIV
DA with at least 1 amenity	274
Number of accessible amenities	723.67
Mean	4.79
Standard Deviation	7.34
Median	1.83
Maximum	41
Minimum	0

Moreover, the DAs with the highest averages are located in the regional core, in agreement with the minimum distance analysis. The regional core is the urbanized belt in the eastern section of the CMA, composed of the old City of St. John's and the City of Mount Pearl (Figure 5.7[13]). Some of these DAs had much higher numbers of services available and one DA offering 41 accessible amenities.

[13] Detailed expanded maps of the urban core can be found in the Appendices.

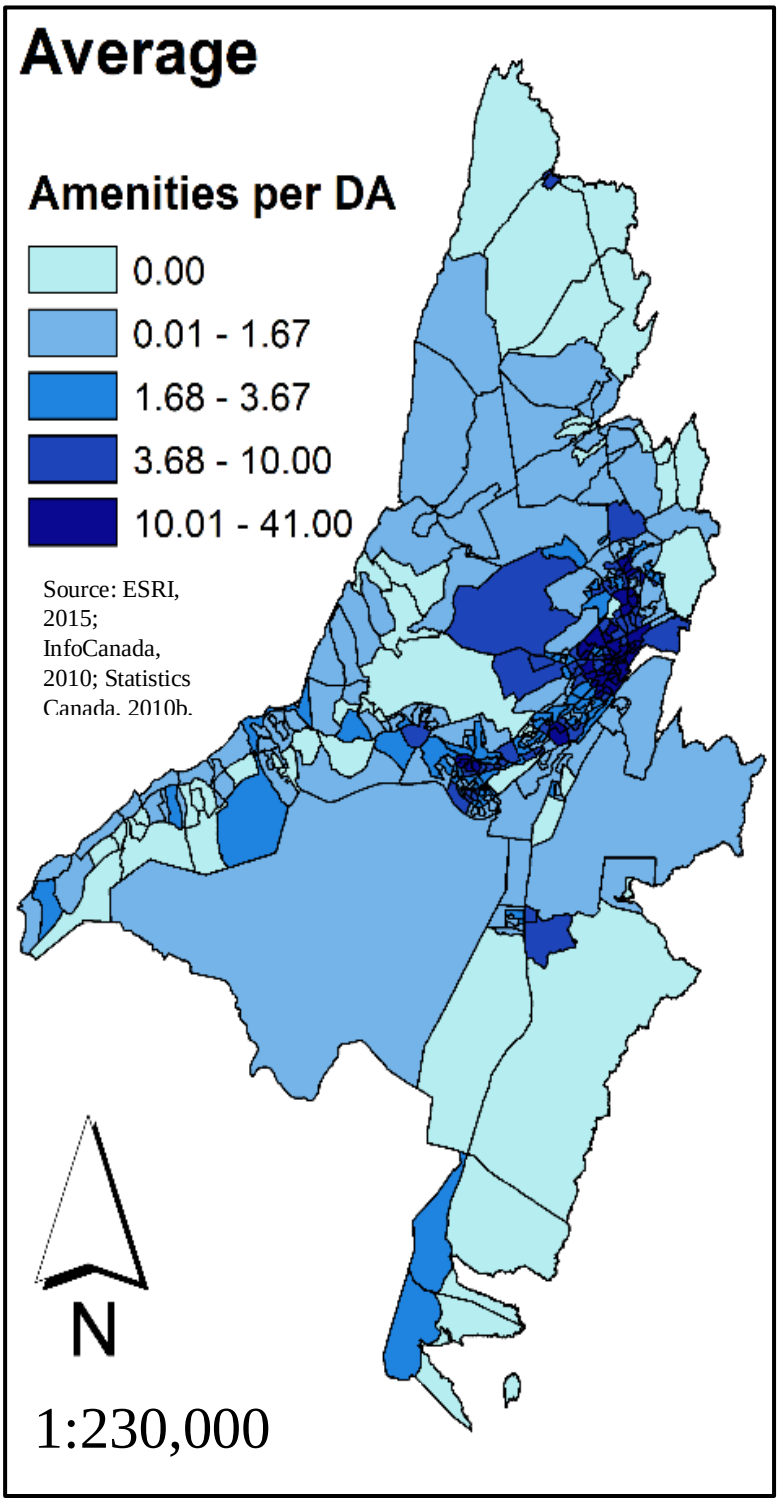


Figure 5.7. Geographical distribution of amenities in the SJCMA under the three coverage criteria average, 2010

When looking at individual types of amenities, there are wide disparities between one type and the other (Table 5.3). Values from averaging the three coverage criteria show that there are far more health services available (286 amenities) to residents in the SJCMA than other amenities. Health services are followed by recreational amenities in availability, with 182.33 services and facilities. At the other end of the spectrum, nursing care amenities show much lower values, with a total of 23.33 amenities across the SJCMA.

Table 5.3. Descriptive statistics by type of amenity for average of three criteria, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

	Amenities	**DAs WAL 1**	**DAs WO**	**MEAN**	**STDEV**	**MED**	**MAX**	**MIN**
Food	123.33	201	117	0.81	1.11	0.33	6.33	0
Schools	52	113	205	0.36	0.65	0	3	0
Rec	182.33	163	155	1.32	3.39	0.33	26.67	0
Health	286	176	142	1.98	3.87	0.33	29.33	0
Nursing	23.33	63	255	0.13	0.33	0	2.67	0
Child	56.67	134	184	0.36	0.59	0	4	0

Distributional values also vary widely by type (Figure 5.8). Food stores are the best distributed – and, as explained previously, are the closest amenities to people –with residents having at least one accessible store in 201 DAs. This is followed by health amenities (176 DAs). Nursing care facilities present the most constrained type of service among those studied, with residents in only 63 out of 318 DAs having walking access to a nursing facility – this agrees with nursing facilities' longer minimum distances.

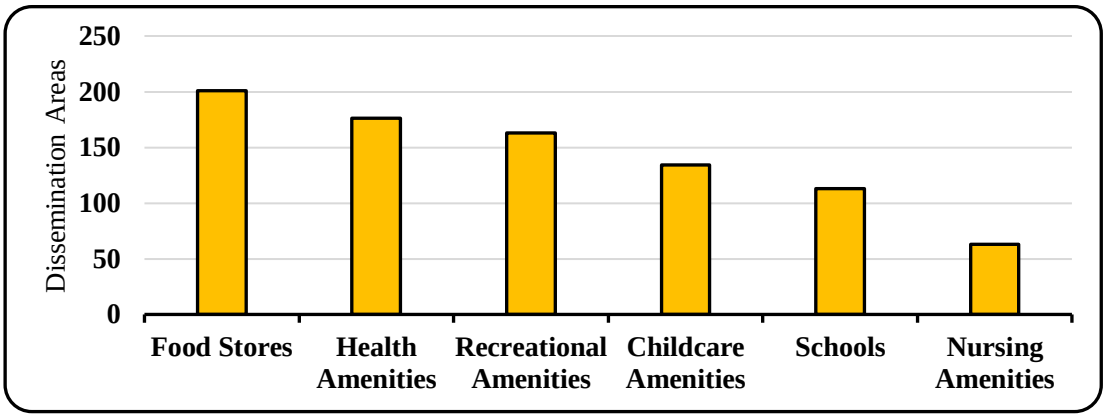


Figure 5.8. Number of dissemination areas with at least one amenity by type of amenity under average of three criteria (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

Spatially, most amenities concentrate in the urban core (Figures 5.9 and 5.10). The majority of schools are located in the urban belt and in the largest towns in the CMA. Food stores are somewhat better distributed, with a concentration in the belt and its immediate periphery, which is logical given the higher availability of food stores in general (as explained in Chapter 2, many food stores in inner cities are smaller shops or convenience stores, which offer less and unhealthier options and at higher prices to the consumer than the bigger stores). Recreational amenities are the third best distributed in terms of DAs with accessible facilities, but they seem to be more spatially diffused, with DAs in all directions showing relatively high concentrations. This may be explained by the fact that many recreational services consist of publicly funded community centers, parks or protected natural areas, which are more commonly found outside of the urban belt (as explained in Chapter 2, playgrounds and parks, for instance, are more common in wealthier neighbourhoods which are located in the suburbs). Health amenities are

concentrated in the belt and its periphery in the expanded City of St. John's, which is where the largest hospitals are located, incentivizing healthcare professionals to establish their offices and clinics in the periphery. Childcare amenities are mostly concentrated along the belt and in the belt's periphery. The only exception to the pattern of amenities centering in the urban core is nursing care facilities, which are most accessible outside of the urban belt.

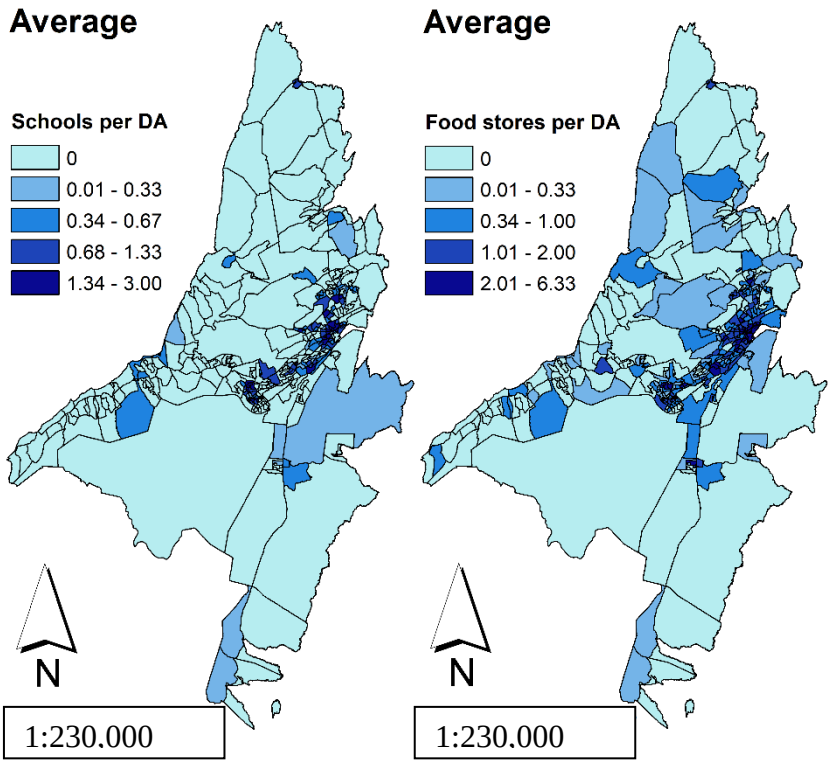


Figure 5. 9. Distribution of six types of amenities in the SJCMA in 2010 (CCIV) (A)

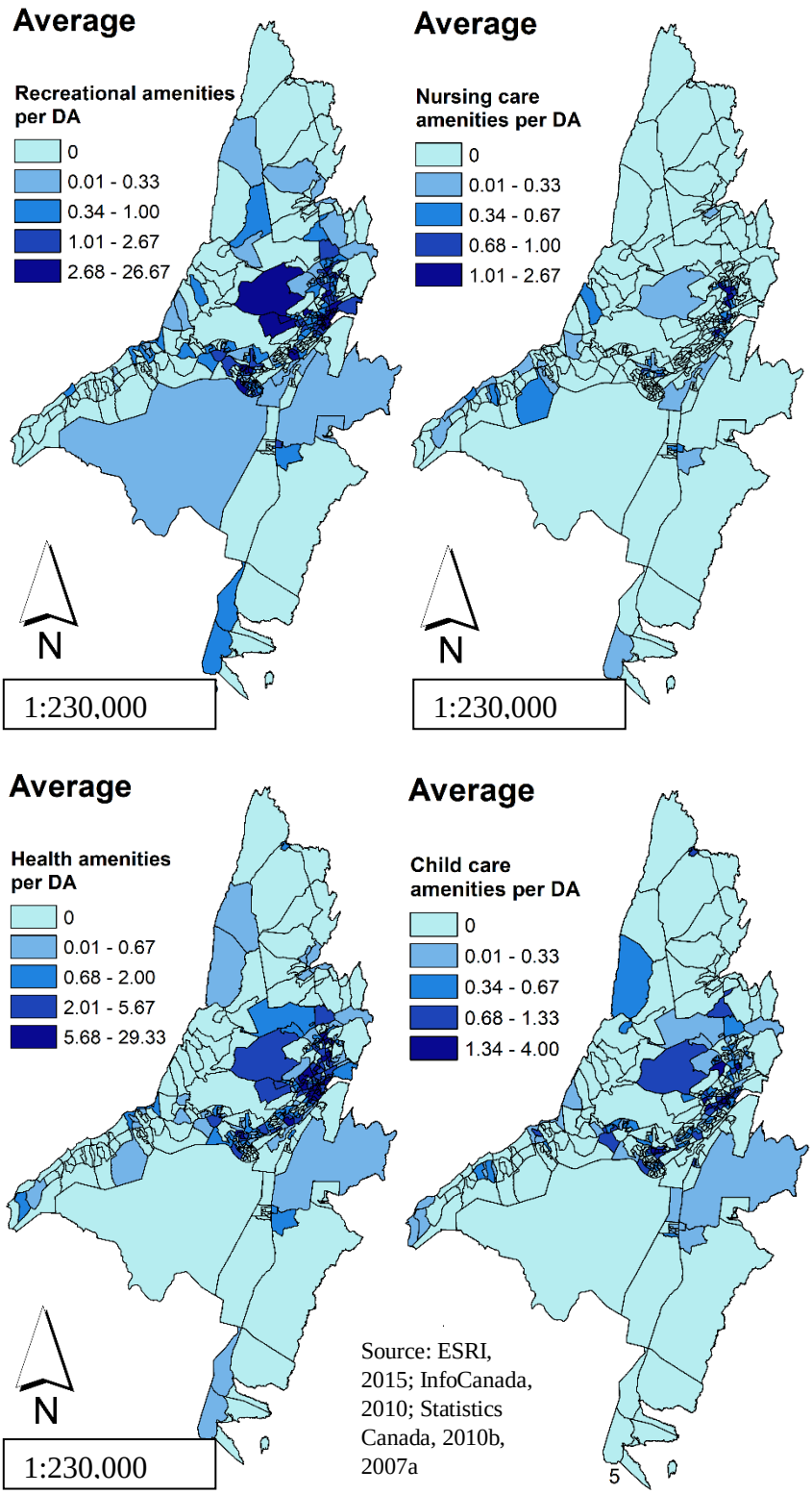


Figure 5.10. Distribution of six types of amenities (SJCMA, 2010) (CCIV) (B)

A last method to determine the level of access using coverage criteria is to measure the "amenity mix," that is, the number of types of services and facilities to which residents of a DA have walking access. In this research, the "amenity mix" yields a score of 0 to 6, with a score of 6 meaning that in a particular dissemination area, residents are able to access at least one amenity of each type (e.g. schools, food stores, etc.). As explained in Chapter 3, much of the literature on cities and the practice of planning have identified land-use mix and self-contained neighbourhoods as strategies that improve and ensure the health and long-term sustainability of cities. My analysis reveals that, on average, the mix score across the SJCMA is 2.67, which means that on average people had access to 2 or 3 types of amenities in their DA. The majority of DAs in the metropolis offered residents walking access to 3 types of amenities, as observed in Figure 5.11. Furthermore, twenty-two DAs offer residents walking access to all 6 types of amenities, which means that the minority of DAs in the SJCMA were self-contained. In addition, the average number of amenities per DA increases as the amenity mix score goes up. That signifies that the more 'mixing,' the more available amenities there are in a given geographic unit.

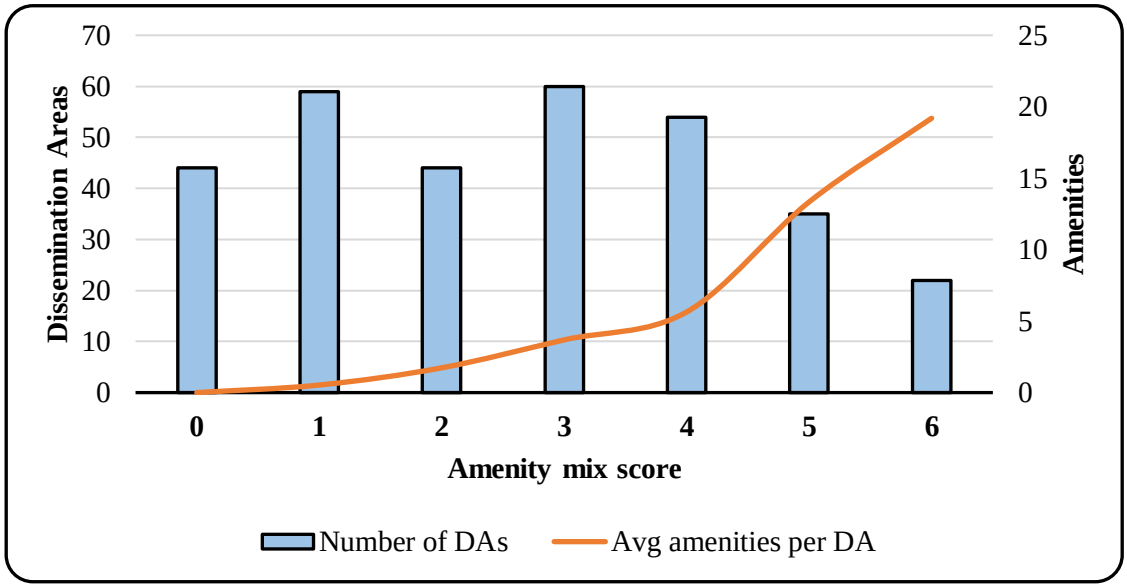


Figure 5.11. DAs and average amenities by amenity mix score (as calculated by averaging three coverage criteria), SJCMA, 2010

Spatially, the pattern of DAs with the higher 'mix scores' is similar to that of average accessibility under coverage and minimum distance criteria (see Figure 5.12). The closer to the urban belt, the higher the mixing. There are a few exceptions, such as in Bauline (northwest) and in Bay Roberts and Witless Bay (southeast), which have scores of 3 or more.

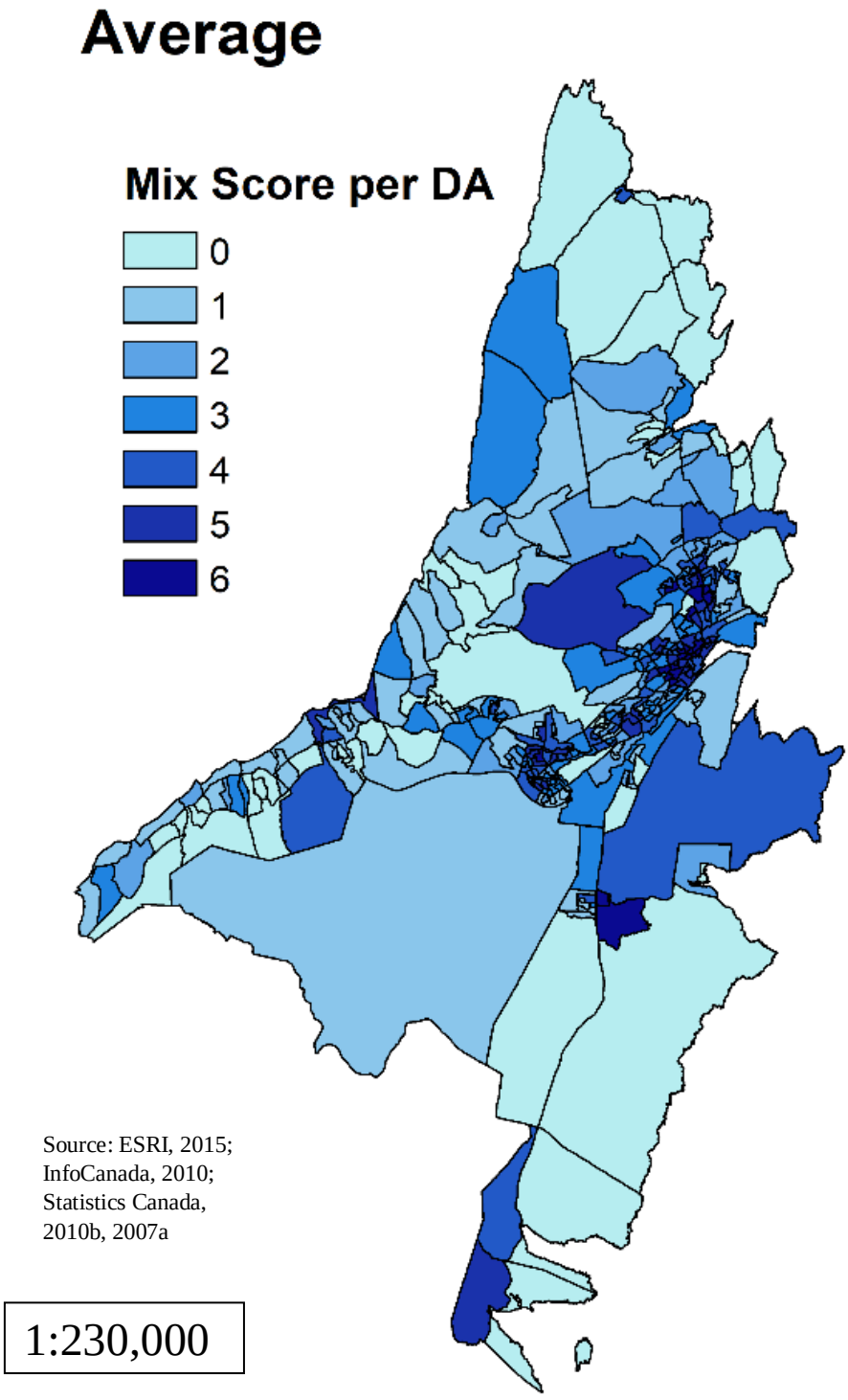


Figure 5.12. Geographical distribution of amenity mix scores in the SJCMA in 2010 under CCIV (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

The findings from the minimum distance and coverage criteria follow a spatial logic – that of density and centrality. First, amenities concentrate where population and building density is higher, which, in this case, is the central DAs, containing the urban belt (Downtown St. John's and Mount Pearl) and its immediate periphery. This concentration is much higher than elsewhere in the SJCMA. This follows Christaller's Central Place Theory, as explained in Chapter 3, which argues that activity consolidates in central areas and this is where accessibility is the highest. But there is an underlying historical reason as well – the City of St. John's and the metropolitan area started in the harbour, which to this day concentrates not only harbour-related activity but also offices, public institutions, cultural spaces, and retail. The harbour is the center of activity in the region. And although the downtown area has been in decline as retail activity and government offices have left for the suburbs (Collins, 2004; Denhez *et al.*, 2000a; 2000b; Shrimpton and Sharpe, 1980), the province and municipal governments have been tackling this decline through heritage preservation enacting legislation such as the first heritage by-law in the city's by-laws in 1977 (Denhez *et al.*, 2000a; 2000b) and using federal and provincial resources, such as the Neighbourhood Improvement Program (NIP) (C.J. Congdon Associates, 1978) and housing funding from the Canadian Housing and Mortgage Corporation (St. John's Housing Corporation *et al.*, 1973).

Without this centrality around the St. John's downtown, there would not be a critical mass of people and activity to make the region a hub that attracts jobs and people. Many residents from commuter towns feed off the St. John's downtown and its immediate periphery – they work and shop there.

The maps above show that the spatial distribution of amenities across the St. John's CMA is very unequal. The urban DAs have the majority of services and facilities, while the suburban and rural DAs do not have as much availability or diversity of activity. The next question worth asking is whether this inequality is not only spatial but social. Do people in higher need have higher accessibility to amenities? The next section addresses this by evaluating need-based accessibility.

5.4. Need-based accessibility

Accessibility can be more accurately evaluated when it is measured against demographic metrics and it is in fact need-based accessibility – accessibility in terms of who needs services the most – the type of evaluation done in most studies on urban access. As reviewed in Chapter 2, social equity is an important dimension of accessibility. While understanding spatial accessibility is essential to determine whether an area is accessible to people or not, equitable accessibility provides a more complete picture. For instance, although accessibility in St. John's seems to be spatially unequal, with suburbs having less accessibility than the urban core, most suburbanites own a car, which gives them an edge when it comes to reaching services and facilities. For this analysis, accessibility is higher when people most in need have better access (Lucy 1981). This section explores need-based accessibility in order to uncover real levels of (in)accessibility as it relates to the population.

5.4.1. Need-based accessibility: A demographic profile of the metropolis

In 2006, there were 181,113 people in the SJCMA (Statistics Canada, 2007). Across the CMA, the mean population was 571.25 people per DA (Table 5.4). The median population was 500 per DA, and the most populated DA had 1,965 people while the least populated DA had a total of 160 people. Spatially, DAs alternate among high, moderate and low ranges of population. Pockets of high population can be found throughout the metropolitan area, in the northern towns such as Pouch Cove and Torbay, in DAs across Paradise, CBS, and Petty-Harbour, and DAs spread around the cities of St. John's and Mount Pearl. The inset map in Figure 5.13 features the urban core of the CMA and shows lower population ranges than in the DAs in the urban periphery. There seem to be, on average, more DAs with lower population numbers in the downtown area overall, which is not surprising given that larger families tend to live in suburban areas.

In this section, I am interested in understanding how accessibility varies according to various demographic groups, some of which are more vulnerable in regards to their ability to reach services. As I outlined in Chapter 2, equity has been a central topic in urban geography and in studies on accessibility, as geographers and other scholars have found that the right to the city is experienced very differently depending on one's background, income, and age, among other factors. The SJCMA has a clear majority of working-age adults and drivers, so seniors, low-income residents, youth and non-drivers are four groups whose accessibility may be highly impaired.

Values for segments of the population by age, income, mode of transport, and place of work are listed in Table 5.4. In 2006, low-income residents made up 23.63% of

the general population, with 49.45% and 5.8% being the highest and lowest low-income percentages in a single DA, respectively. In addition, children and youth (0 to 14) constituted 16.07% of the general population in the CMA, with a maximum and minimum percentages by DA of 31.48% and 0.81%, respectively. Senior citizens constituted 11% of the general population, with the highest senior population in a DA being 69.15% and the lowest being 0%.

Regarding mode of transport used for commuting to work, the majority of the working-age population – 88.17% – used private motorized vehicles as their main mode of transportation, both as a driver and passenger. The highest percentage of private motorized vehicle users in a single DA was 100% and the lowest was 27.78%. People who got to work via alternative modes of transport, such as public transit, biking or walking, were in the minority – 10.02% – with 61.11% being the highest percentage of this segment in a single DA and 0% being the lowest.

A last segment of the population analyzed in this research is the percentage of working-age residents with a workplace outside of their census subdivision and census division of residence. This demographic category is important in understanding gaps between where people live and where people work. In a self-contained neighbourhood, people can dwell and work in a same area. This is enabled by mixed-use urban forms. The values found in census data only provide information for subdivisions and divisions. A subdivision is as big as a town or a city. In the SJCMA, 37.31% of the general population worked outside of their municipality, with a maximum percentage of 92.59% in a single DA. More than a third of the working-age population commute to a different

municipality for employment, while the median commuting distance for the SJCMA is 5.5 km (this value increases significantly as one moves further from the City of St. John's).

Table 5.4. Descriptive statistics for census data, SJCMA, 2006 (Source: Statistics Canada, 2008)

	Pop. %	MEAN	MED	STDEV	MAX	MIN
Population	100	571.25	500	244.56	1965	160
% Low Income	23.63	23.81	23.72	7.30	49.45	5.80
% 0 to 14	16.07	15.66	15.77	4.81	31.48	0.81
% Seniors	11.00	11.00	9.65	8.12	69.15	0.00
% Private motor users*	88.17	86.63	91.49	13.24	102.04	27.78
% Non-private motor users*	10.02	11.51	6.45	13.22	61.11	0.00
% Working outside of subdivision*	37.31	35.78	17.55	30.73	92.59	0.00
% Working outside of census division*	1.72	1.82	0.83	2.67	25.00	0.00

*these percentages are calculated from working age population (15 y.o.a. and above)

The SJCMA is, in short, an autocentric society that undervalues alternative modes of transportation. The high percentage of drivers can also explain longer commuting times, as people dwell far from their place of work, often in so-called commuter towns, whose viability depends in great part on the urban core's economy, in this case, St. John's. To be sure, the suburban culture that is observed in the SJCMA is common across Canada and North America (Grant, 2001). A majority of residents and consumers value lifestyles that are characterized by residential and commercial decentralization. As a consequence, there is a widening spatial gap between origins and destinations, a point that is important to make when discussing accessibility. The city and the metropolis

become less accessible the more people choose low-density suburban living as opposed to higher density mixed-use urban neighbourhoods.

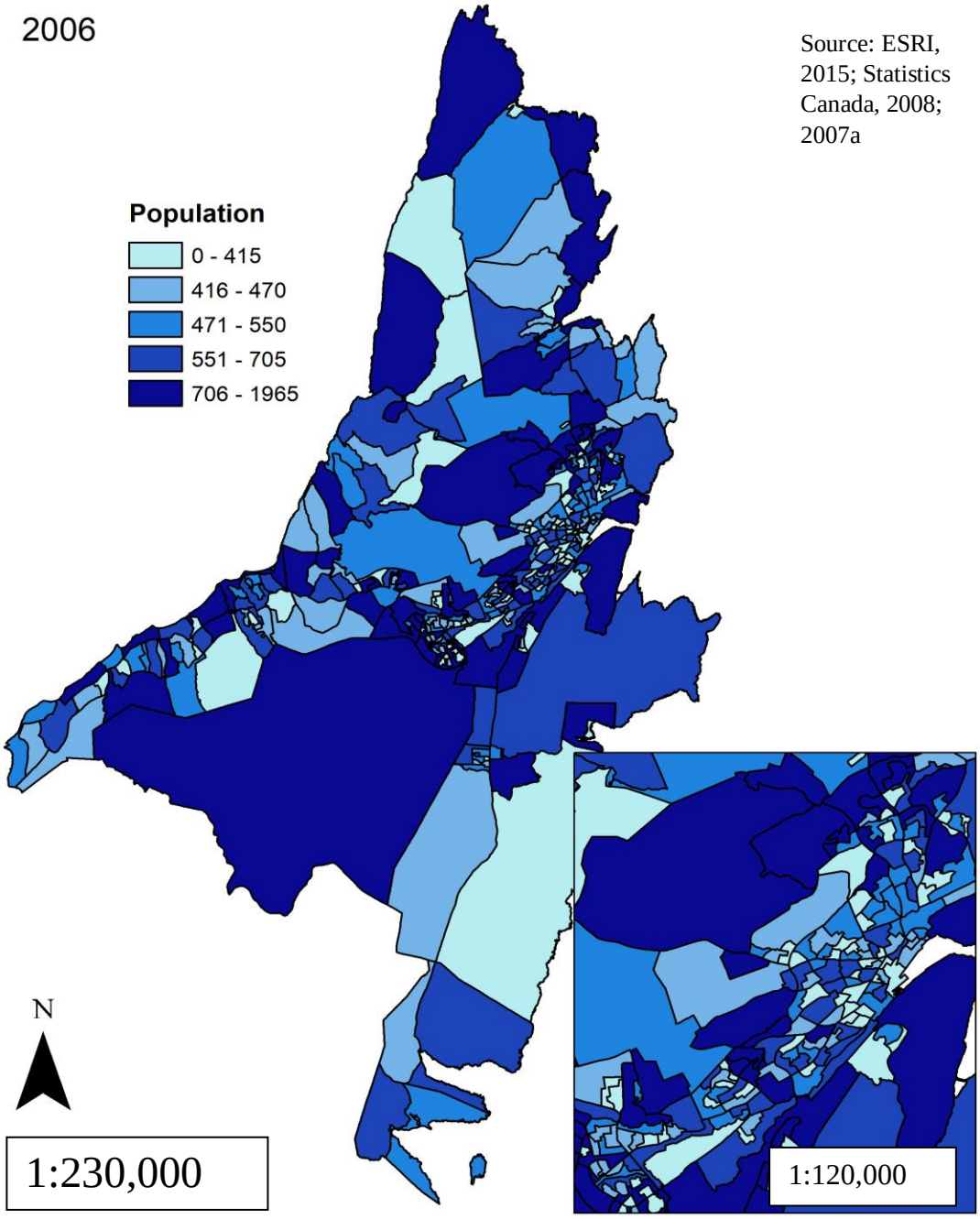


Figure 5.13. Geographic distribution of the population by DA in the SJCMA in 2006

5.4.2. Need-based accessibility to total amenities

In this section, I compare demographic data to the average number of accessible amenities drawn from the three coverage criteria covered above in order to assess whether accessible amenities are located in proximity to where people live. Total DAs and amenity averages vary as population increases or decreases. Figure 5.14 shows DAs and average amenities per DA by population values. As per the median value of the population, the majority of DAs have 450 to 599 people, while the highest average number of amenities is found is DAs with a population of 300 to 449, which in 2010 had access to an average of 5.96 amenities. As the population increases, the average number of accessible amenities per DA decreases in nearly a linear fashion, with the highest population range – 1000 to 2000 people – having walking access to 2.07 amenities per DA on average. This relationship between amenities and population indicates a spatial 'mismatch' between the two, which, in turn, indicates lower accessibility.

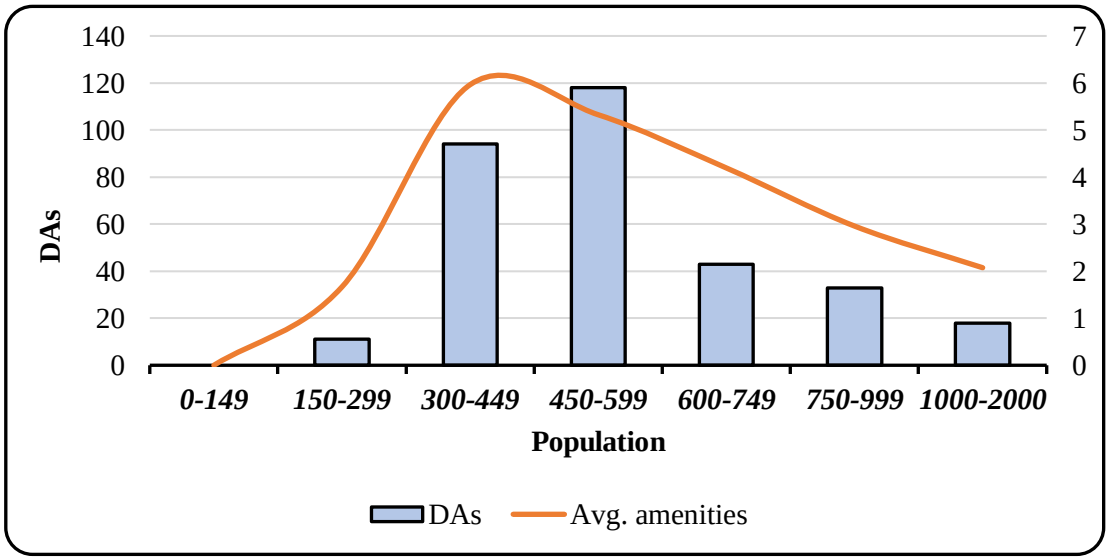


Figure 5. 14. DA count and average number of amenities by population ranges in the SJCMA (Source: Statistics Canada, 2008; 2007a)

Given that there is a mismatch of amenities to population, it is clear that accessibility in the SJCMA is spatially unequal – some areas enjoy higher access than others. Spatial analysis of amenities per capita in the SJCMA (Figure 5.15) shows that the DAs with the highest amenity to population ratios are primarily concentrated in the urban belt or regional core of the CMA. Within this area, DAs with the highest ratios are located in Downtown St. John's and the western portion of Central St. John's. Other pockets of high values are distributed across the metropolitan area, such as Pouch Cove, Torbay, Mount Pearl, Paradise and CBS.

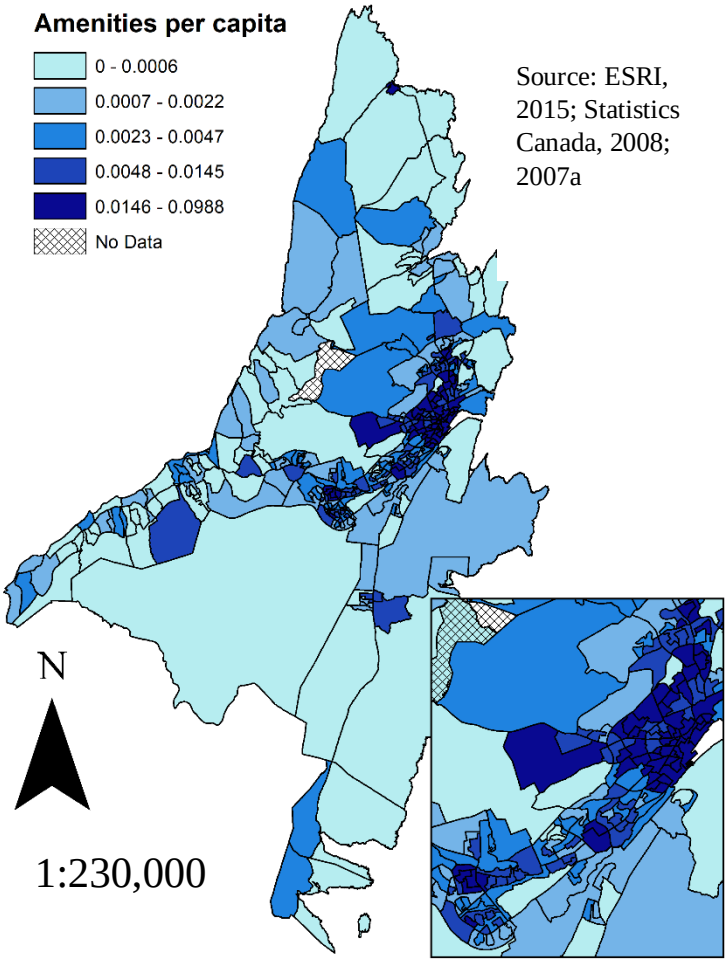


Figure 5.15. Distribution of DAs by amenities per capita, SJCMA, 2006-10

Whereas the ratio of amenities to population shows a clear spatial inequality, the relationship between population and amenity mix score is more constant (see Figure 5.16), where average population per DA does not vary substantially. The highest population average (630.91 persons) is found in DAs with a mix score of 2, an average number of amenities of 1.74 and an average minimum distance of 566.41 meters. The lowest population average is in DAs with access to 6 different types of services, 19.20 amenities on average and a minimum distance of 242.85 meters.

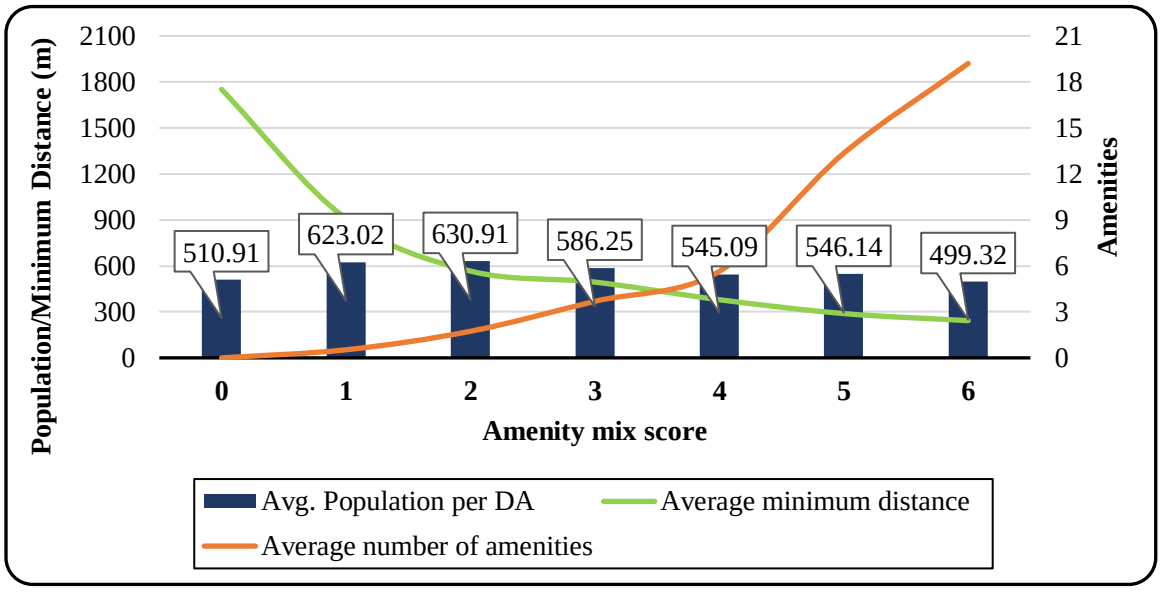


Figure 5.16. Population and minimum distance per amenity mix score, SJCMA, 2006-10 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

It is important to note from Figure 5.16 that DAs with higher mix scores – that is, with more mixed land uses – also have a higher average number of amenities and a lower average minimum distance. A possible explanation is that the more mixed a neighbourhood is, the higher its accessibility and walkability because there are more types of amenities reinforcing each other and creating a market for subsequent

businesses, which in turn attracts more people who may move in to the new neighbourhood. As Jane Jacobs (1961) once adroitly argued, people create and support economic activity in the city, but this has to happen in a geographic context that enables a certain level of land-use mix. In the SJCMA, this mix exists in the old City of St. John's, which has the appropriate urban form to encourage the mingling of social interaction and economic activity.

By demographic group

For total population, as explained above, there is a spatial mismatch, but it is as essential to understand the variability of accessibility for different demographic groups in order to evaluate equity in accessibility. The first analysis in this regard yields the average number of amenities by population range for various segments of the population (see Figure 5.17 and Table 5.5). In DAs with the highest concentration of non-drivers, the average number of amenities per capita is 10.67. For all other categories, the highest population range found is 250-299 people. In DAs with that range of population, low-income residents have the highest average number of accessible amenities, at 2.95. Drivers constitute the segment with the second highest level of accessibility in that population range, who enjoy access to 2.73 amenities on average. The demographic group with the lowest average number of amenities per capita is children and youth, who on average have access to 0.67 where they most concentrate.

Table 5. 5. Average number of amenities by demographic group in the SJCMA, 2006-10 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

Population ranges	0 to 14	Low Income	Seniors	Drivers	Non drivers
0-49	3.66	3.17	4.19	6.08	2.90
50-99	6.64	4.36	5.22	13.35	12.14
100-149	3.52	5.15	4.81	9.50	18.15
150-199	1.01	6.23	8.26	5.31	10.67
200-249	0.74	6.98	2.00	2.38	x
250-299	0.27	2.95	2.67	2.73	x

Here we see that accessibility varies significantly from demographic group to demographic group. The most vulnerable to lack of accessibility to amenities are children and youth as well as seniors. In Figure 5.17, population ranges are plotted against average amenities. We can observe that non-drivers have the highest number of average amenities among all groups and ranges. This is closely followed by drivers.

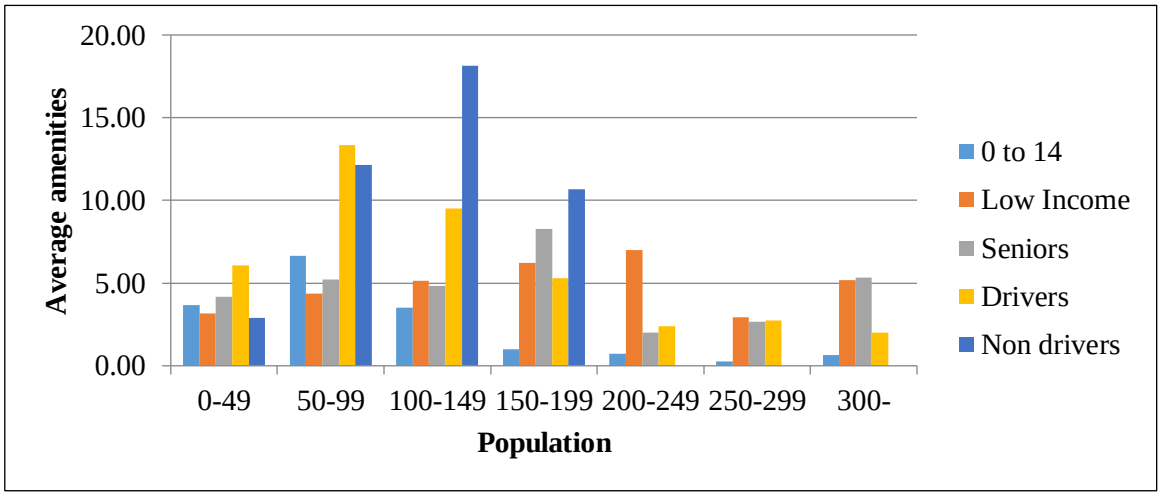


Figure 5.17. Population and average amenities per demographic group (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a

When plotting population against average amenities and minimum distance per DA for the demographic group of 0 to 14 year-olds, we see that as the population increases, the number of amenities accessible in those DAs decreases in a linear fashion (Figure 5.18). The most pronounced shift takes place between the first and second population column. The exception is with the last population range (300 and more), where accessible amenities increase significantly. Regarding amenity mix, the variation is relatively small, with the highest value in DAs with 0 to 49 children (3.69 types of amenity) and the lowest (1.80) in the 250-299 population range. In terms of minimum distance, the lowest value is at the first population column and the highest (4108.23 m) is found in DAs with 300 or more children. For this group, then, accessibility is low. This can be explained by the fact that most large families live in suburban developments or commuter towns, where houses are bigger and can house families with children.

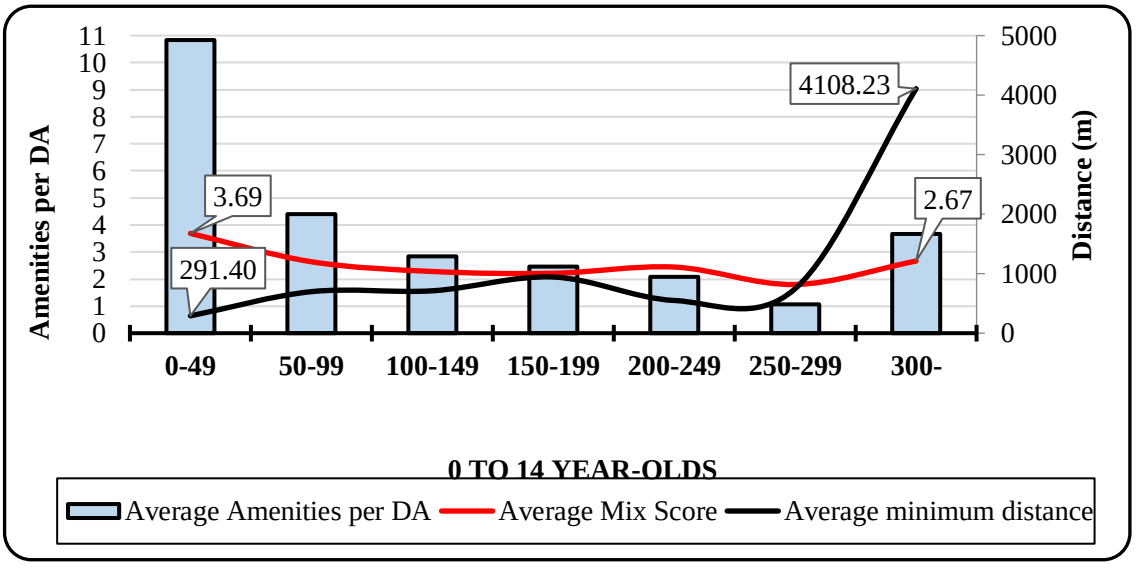


Figure 5.18. Average amenities, mix score and minimum distance by population of 0 to 14 year-olds, SJCMA, 2006-10 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008;

In the case of seniors, the same analysis yields very different results. The number of average accessible amenities is highest in DAs with an average of 150 to 199 seniors (8.26 accessible amenities), whereas accessible amenities are at its lowest (2.67 amenities) in DAs with 200 to 249 senior residents (see Figure 5.19). Amenities per DA increase again when the senior population is 300 or more. Regarding the amenity mix score, the highest value (4) can be found in DAs with 150 to 199 seniors and the lowest value (2) is found in DAs with 200 to 299 seniors. Values for minimum distance vary widely, with the lowest distance (295.80 m) found in DAs with 200 to 249 senior residents. The highest minimum distance to the closest amenity is found in DAs with 300 or more residents aged 64 or more. Despite the latter value, minimum distance decreases as a whole as population increases. These results show that seniors enjoy higher accessibility than children and youth, but still face longer distances. Nevertheless, the higher the population of seniors, the higher the amenity mix, which indicates that seniors have a wider menu of services and facilities.

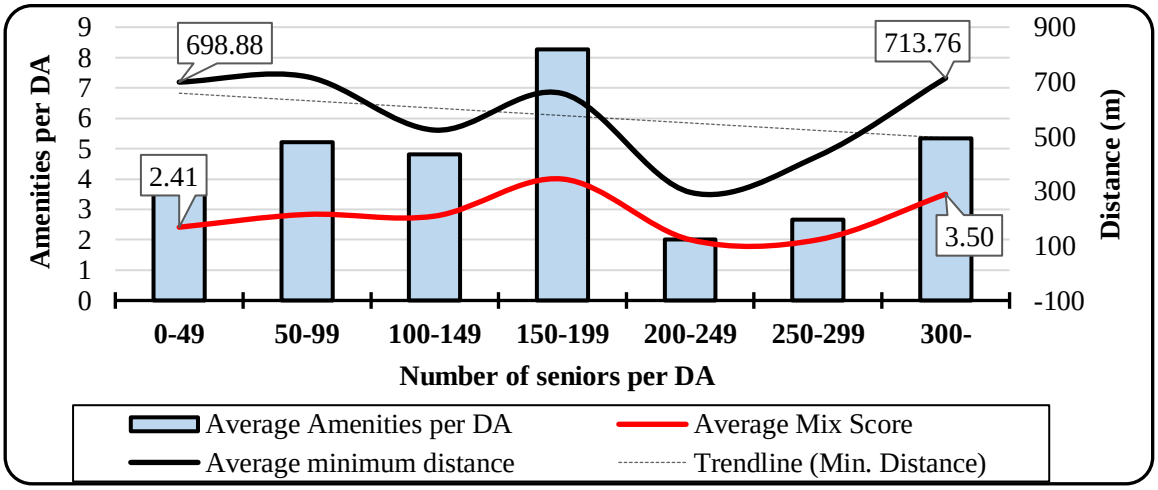


Figure 5.19. Average amenities, mix score and minimum distance by population of seniors, SJCMA, 2006-10 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

Low-income residents constitute a third demographic group analyzed in this research. Research has shown that low-income and poor residents in cities around the world face major hurdles in accessing services, with many of them facing spatial gaps such as food deserts (Walker *et al.*, 2010). In the SJCMA, this does not seem to be the case, at least in general terms. My analysis shows that the number of average amenities increases linearly as the low-income segment of the population increases, with the exception of the second to last population range of 250 to 299, which presents the lowest number of amenities (2.95) (Figure 5.20). The highest number of amenities is found in DAs with 200 to 249 low-income residents. The average mix score increases slightly from 1.86 to 3 as the low-income segment of the population increases. Minimum distance varies widely, with the lowest minimum distance (497.15 m) found in DAs with a low-income population of 150 to 199 and the highest value is found in DAs with 300 or more low-income residents. The trend, however, is increasing as the population increases.

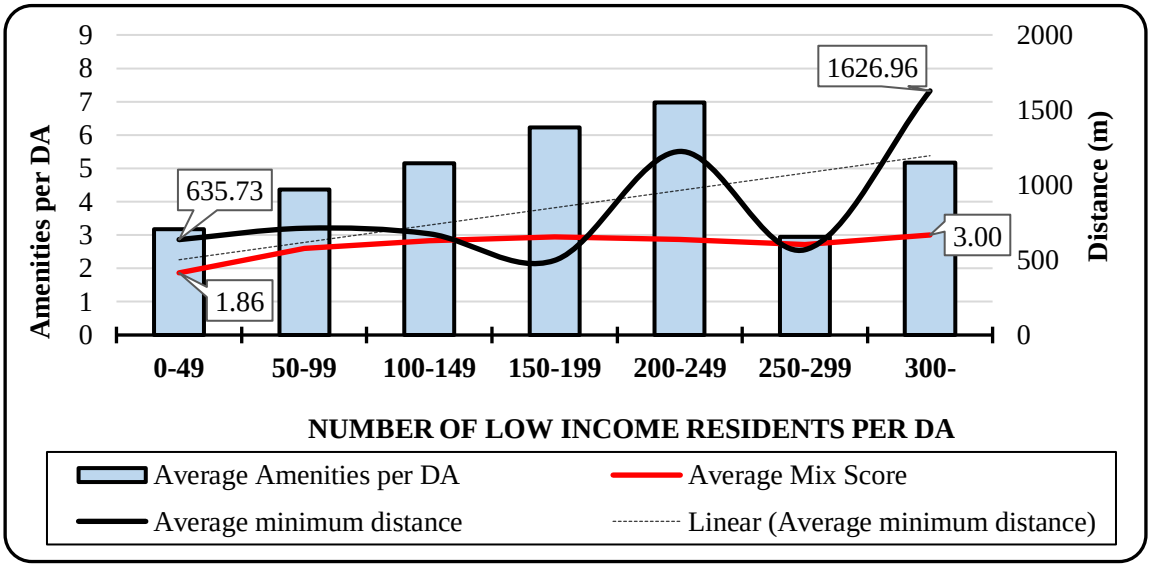


Figure 5.20. Average amenities, mix score and minimum distance by population of low-income residents, SJCMA, 2006-10 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

A fourth population grouping of interest are residents who use a private motorized vehicle as main mode of transport, hereinafter defined as "drivers." For this group, our findings reveal that as the driver population per DA increases, the number of accessible amenities decreases (Figure 5.21). The highest value is found in DAs with 50 to 99 drivers (13.35), while the lowest value is found in DAs with 300 or more drivers (2.01). Furthermore, a similar trend is found for amenity mix scores, with the highest score value of 3.88 found in DAs with 50 to 99 drivers and the lowest score (1.85) found in DAs with 200 to 249 drivers. Minimum distance values present an opposite trend, with the longest distance (969.20 m) found in DAs with 300 or more drivers and the shortest minimum distance (214.20 m) found in DAs with 50 to 99 drivers. These values show that drivers have very low walking accessibility to amenities, but their accessibility is much higher than other groups given that they can drive.

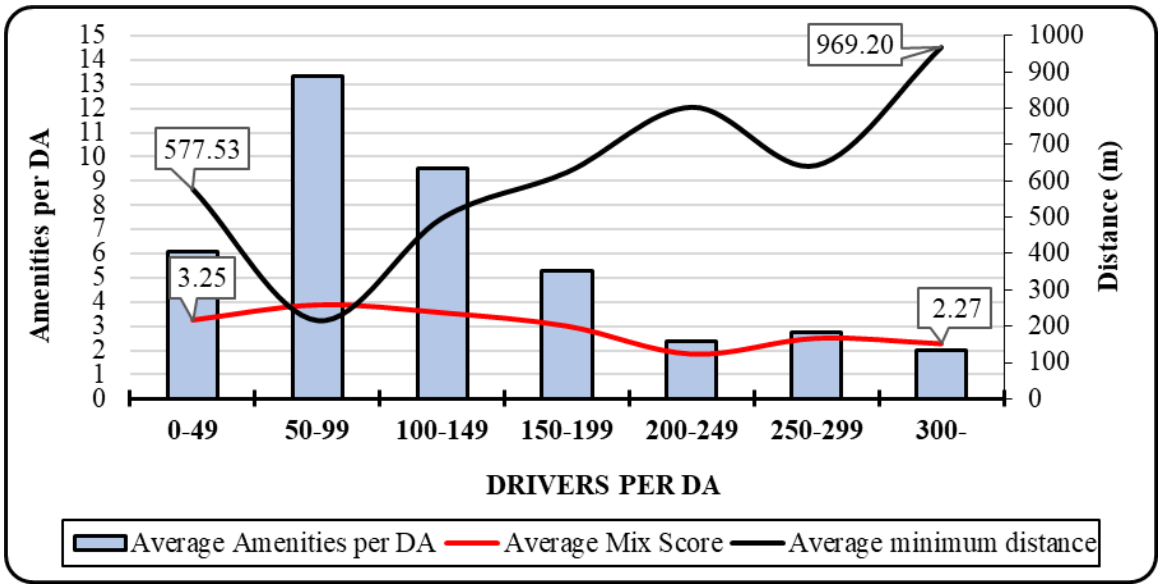


Figure 5.21. Average amenities, mix score and minimum distance by population of drivers, SJCMA, 2006-10 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

The last demographic group analyzed in this study is the portion of the population using public transit, biking or walking as main modes of transport, hereinafter referred to as "non-drivers." Research has shown that cyclists and pedestrians face major spatial challenges in navigating the city and reaching services and facilities, because streets and urban spaces are not designed for them, but for drivers (Lo, 2009; Talen, 2002). My analysis found that, for this group, the average number of amenities per DA increases as the population of non-drivers goes up, with the exception of DAs with 150 to 199 non-drivers (Figure 5.22). The lowest number of amenities (2.90) is found in DAs with 0 to 49 non-drivers, whereas the highest number (18.15) is found in DAs with 100 to 149 non-drivers. The mix score also increases as the non-driver population increases. Average minimum distance is much lower in DAs where there are more non-drivers. The furthest minimum distance (786.31 m) is found in DAs with 0 to 49 non-drivers, whereas the shortest distance (191.90) is found in DAs with 100 to 149 non-drivers. These findings indicate that non-drivers have much higher accessibility than other demographics.

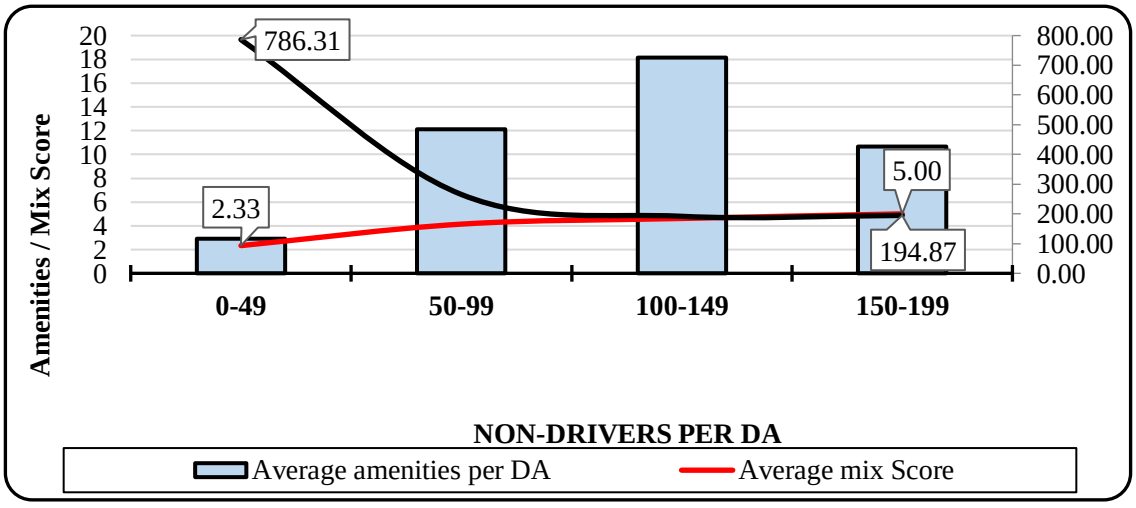


Figure 5.22. Average amenities, mix score and minimum distance by population of non-drivers, SJCMA, 2006-10

5.4.3. Need-based accessibility by type of amenity

In the subsequent subsection of this analysis, need-based accessibility is assessed by type of amenity. As it can be observed in Figure 5.23, where average amenities by type is plotted against population, DAs with a population of 300 to 449 have the highest average number of recreational amenities (1.73 amenities), food stores (1.04), and childcare services (0.46). DAs with a population between 450 and 599 have the highest average number of health amenities (2.41), schools (0.44) and nursing amenities (0.16). DAs with a population of a 1000 to 2000 people yield the lowest values for schools (0.07 amenities on average), food stores (0.18), health amenities (0.11) and childcare amenities (0.09).

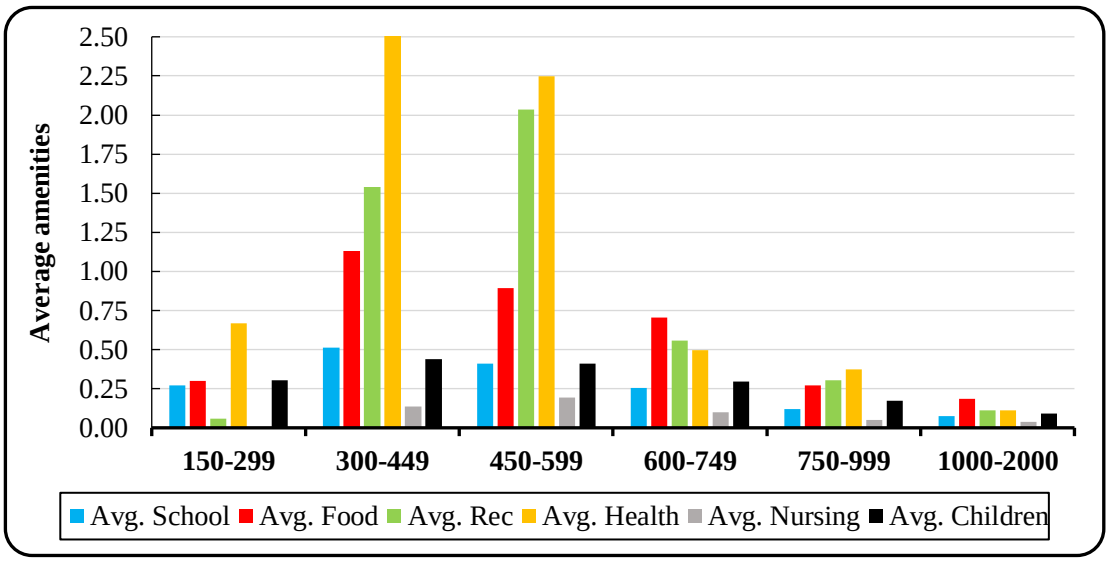


Figure 5. 23. Average amenities by type and population ranges, SJCMA, 2006-2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

These results indicate that there are numerous health amenities across the SJCMA, which is reasonable given its aging population, but there are not as many nursing care facilities. Many of these health amenities are doctor's offices or the offices

of other health professions, because they can often operate near or within a residential area. However, for nursing care facilities as well as other types of amenities, their operation is prohibited in many of the residential neighbourhoods and are only allowed to exist in neighbourhoods zoned for commercial or institutional activities. These limitations constrain one's accessibility in a significant way, leading to long-term consequences that can be costly and unsustainable.

Spatial distribution of amenities to general population (by type of amenity):

The number of amenities per capita for all 6 types was mapped out across the SJCMA (Figures 5.24 (a) and 5.25 (b)). The analysis shows that, with the exception of nursing care services, the highest ratios are found along the urban belt in the regional core. Schools are the most pronounced case, with the highest per capita values in the St. John's downtown area. In the case of food stores, higher per capita values are also found in northern and western DAs in the CMA. Recreational amenities are the type of service best distributed on a per capita basis across the CMA, while health amenities present the highest ratios in the central portion of the metropolis. Nursing care to population ratios are higher mostly in eastern Central St. John's and CBS.

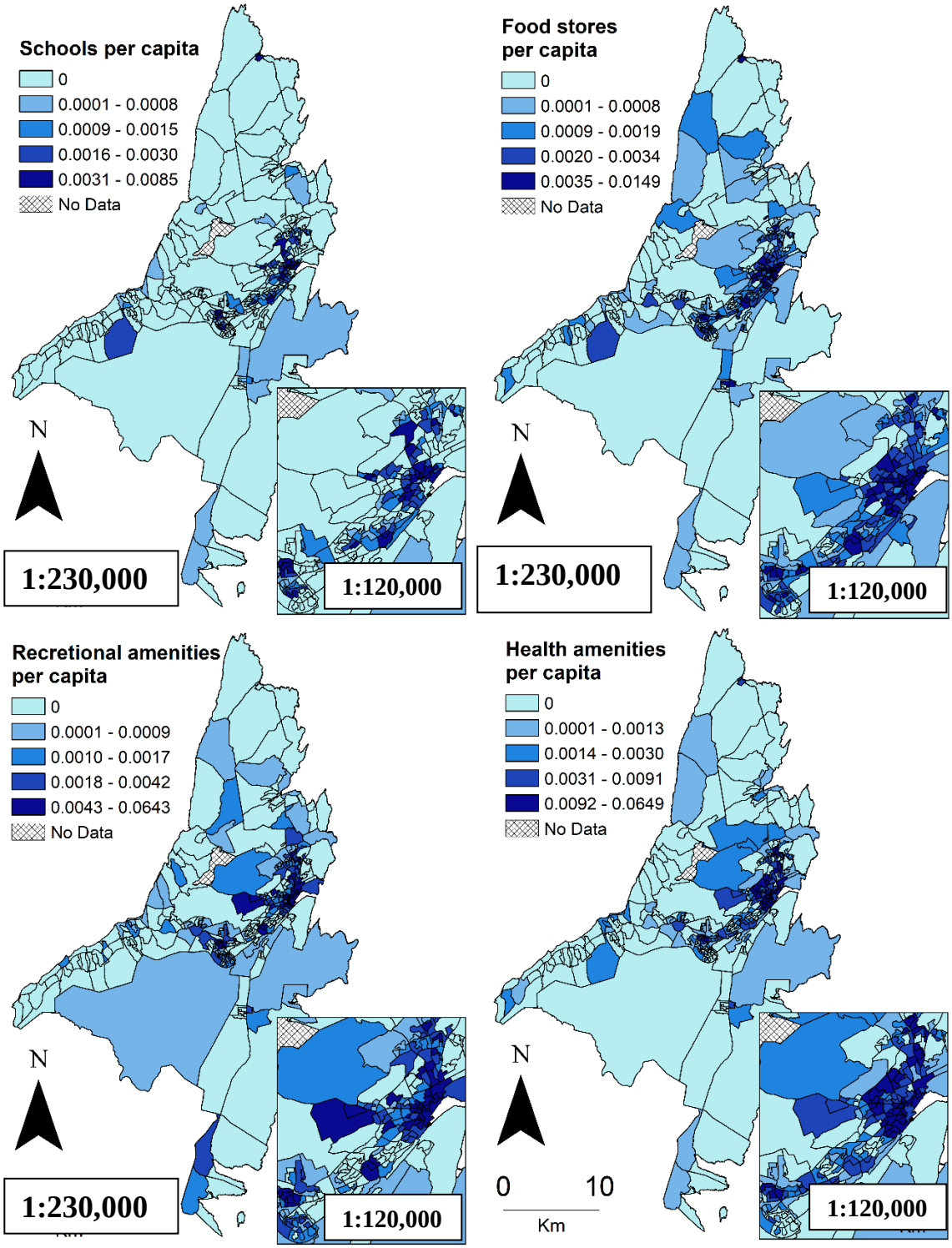


Figure 5. 24. Distribution of amenity-population ratios by type of amenity, SJCMA, 2006-10 (A)

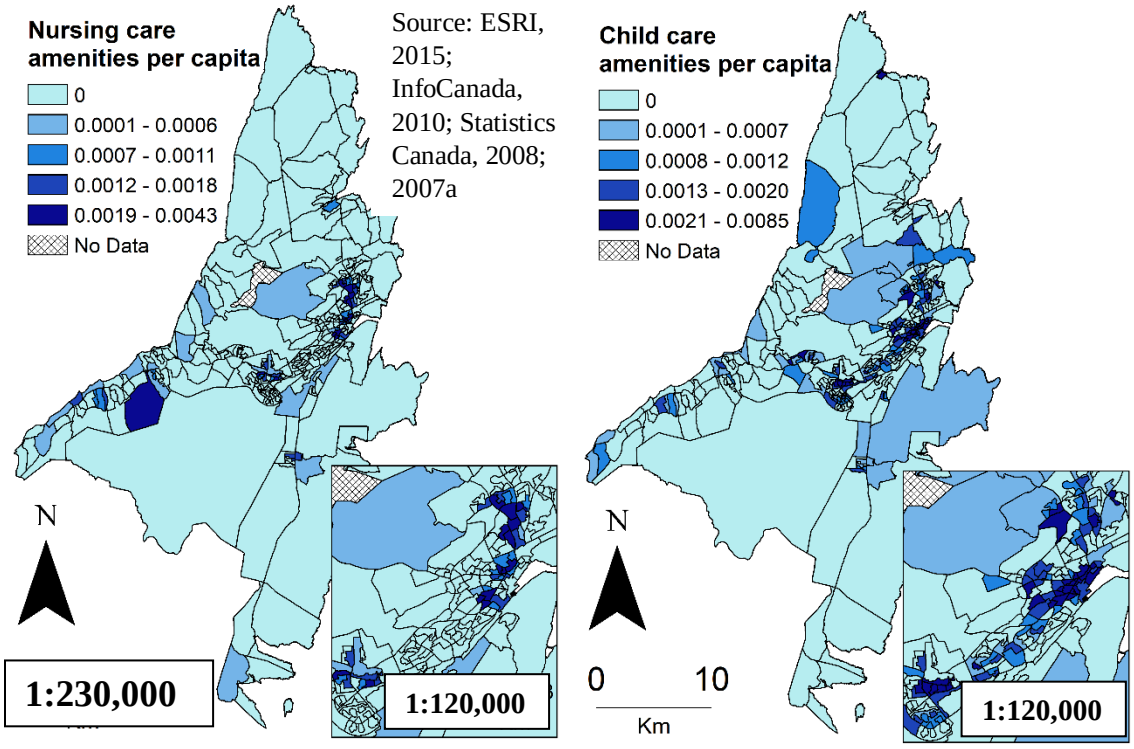
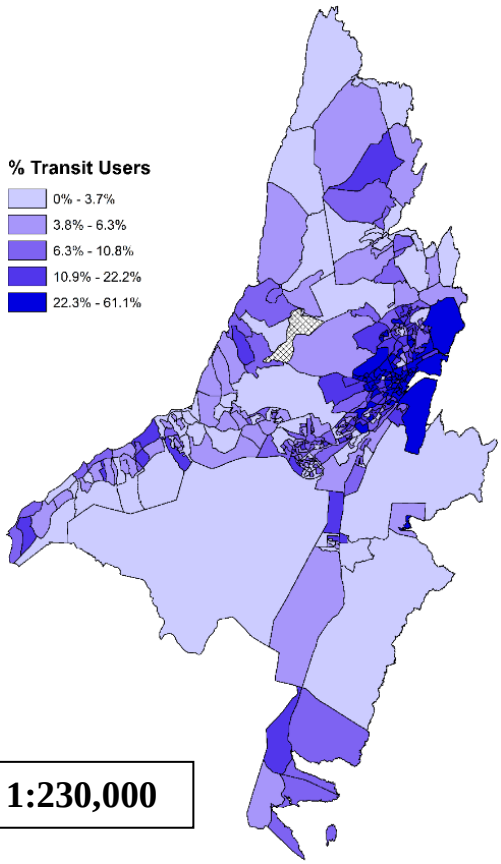


Figure 5.25. Distribution of amenity-population ratios by type of amenity, SJCMA, 2006-10 (B)

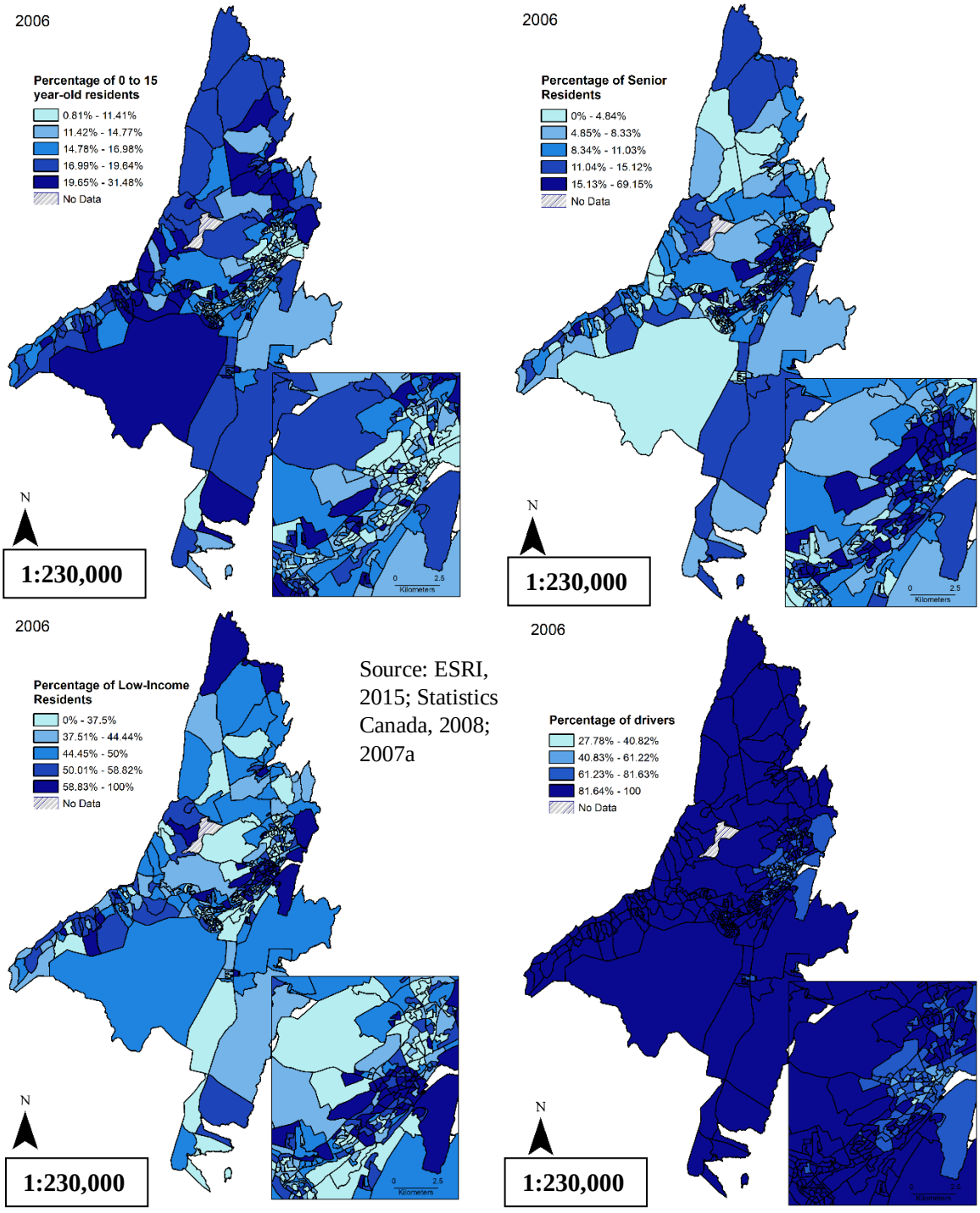
Spatially, the demographic groups that enjoy the highest access to amenities are concentrated in the urban belt. Maps of the distribution of all five demographics (Figures 5.26 and 5.27) shows that, on one hand, the majority of seniors and non-drivers concentrate inside the urban belt, in areas with a higher concentration of amenities. This map helps explain the increasing number of amenities as the population of this demographic increases. On the other hand, drivers and children/youth concentrate outside of the urban belt, which corresponds to areas with lower levels of accessibility to amenities. The last group corresponds to low-income residents, whose population distribution is more scattered than the other groups, having both higher and lower

accessibility, depending whether the DA in which they concentrate is in the urban core or outside of it.



Source: ESRI, 2015; Statistics Canada, 2008; 2007a

Figure 5.26. Distribution of five demographic groups across the SJCMA, 2006 (A)



Source: ESRI, 2015; Statistics Canada, 2008; 2007a

Figure 5. 27. Distribution of five demographic groups across the SJCMA, 2006 (B)

Demographically, the results reveal that areas where accessible facilities, services and institutions concentrate have very different dominant demographics than the areas where there are less accessible amenities. Below is an integrated ranking of demographic groups by their accessibility to all amenities and each type of amenity, based on the average number of amenities per DA for DAs with 150 to 199 people and for DAs with more than 300 people[14]:

1- Non-drivers
2- Seniors
3- Low-income
4- Drivers
5- Youth

Starting from the last group in the ranking, children and youth (people of 0 to 14 years of age) are the most access-constrained group. On average, they have access to 0.11 schools, food stores, health and children care facilities or services. They have access to 0.22 recreational amenities per DA on average. The reason for this has to do with location: pockets of concentration of 0 to 14-year-olds are located outside of the urban belt. Most DAs located in old St. John's, in particular those closer to the harbour, have between 0.81 and 16.98% of 0 to 14-year-old residents, mostly below the 16.07% metropolitan mean for this group. Higher percentages are found in the south of the expanded City of St. John's, which is mostly rural and the commuter towns of Paradise,

[14] The reason for choosing these two population ranges is that 150 to 199 is the largest population value per DA for non-drivers; there are no DAs with more than 199 non-drivers. Therefore, in order to compare values for all demographic groups, the largest population range with all 5 groups was chosen. The 300+ range is the largest population range for the other 4 groups. Their ranking values were achieved by integrating their 150-199 ranking and 300+ ranking.

CBS and Torbay. These areas are also where most families live and where there are larger and single-detached housing, the preferred form of housing for families in Canadian cities up to this day (Statistics Canada, 2017).

The second to last group in the ranking corresponds to drivers. Most DAs in the SJCMA have between 81.64 and 100% of drivers, but the few DAs with lower percentages (27.78 to 61.22 %) are concentrated in old St. John's. This is not surprising, given that most drivers live in the suburbs and commuter towns, where families reside, incomes are higher and parking is plentiful. In addition, they have very low access to schools and child care facilities, which is a significant mismatch, given that many drivers have families with children. However, it is worth noting that, as drivers, they experience spatio-temporal scales in a much more different way than pedestrians or transit users do and can easily access amenities regardless of the distance.

Low-income residents have the third highest level of accessibility in DAs. The high accessibility value can be explained by the fact that there are low-income residents throughout the SJCMA in all directions, with a slight concentration in the southwestern and eastern portions of old St. John's, Pouch Cove, and CBS, where there are more accessible amenities on average. In terms of specific types of amenities, low income residents have low access to schools and nursing care facilities, but high access to food stores and recreational, health and child care amenities. This means that low-income families with children have a hard time finding the facilities they need most – schools – and low-income seniors face similar challenges in finding proper nursing care amenities. However, the higher accessibility to food stores, recreation and health is important, given

that low-income residents tend to have lower mobility than higher-income households (Conference Board of Canada, 2018). The concentration of lower-income households in old St. John's is due to the fact that historically, they have been less spatially mobile than higher earning households, who left the city for the suburbs. Low-income households also rely on public transit and short distances to get to places and jobs.

The demographic with the second highest level of accessibility is senior residents. Their relatively high accessibility can be explained by the location of DAs with higher percentages of senior residents. DAs with 15.13% to 69.15% of seniors reside in old St. John`s, mostly in the neighbourhoods to the northeast. The northeastern portion of Central St. John`s is also where most accessible amenities concentrate. Historically, seniors today were the first or second generation to move out of the St. John`s downtown into Georgestown, with the first expansion of the city, and subsequent neighbourhoods built in the 1950s, 1960s and 1970s, such as Churchill Park, Glenridge Crescent, Virginia Park and Cowan Heights (Collier, 2011b). While younger families started to move further out, seniors remained in these areas. In terms of need-based accessibility, seniors enjoy higher than average access to health and nursing care amenities but low access to food stores in DAs with the highest concentration of this demographic. It is worth noting that in DAs with 200 to 299 senior residents, residents of this demographic have no access to nursing care or recreational amenities.

The group enjoying the highest access to amenities is non-drivers, which includes people who use public transit, walk or bike as their main mode of transport. In dissemination areas with 150 to 199 non-drivers, which is the highest range of non-

drivers per DA in the SJCMA, the average number of accessible amenities is 10.67, more than twice the metropolitan mean. This value can be explained by the concentration of non-drivers in old St. John`s, where there are between 22.3% and 61.1% of non-drivers. This is exactly the opposite to drivers. Specifically, non-drivers have relatively high accessibility to food stores, schools, health amenities and nursing care facilities. Therefore, it may be possible that seniors and low-income households who are also non-drivers have relatively good accessibility to amenities in higher need.

A comprehensive assessment of accessibility in the SJCMA thus reveals that, although average distances to amenities across the region are much higher than the walking standard, these values and the values from the coverage criteria differ greatly by area. Residents in old St. John`s have accessibility above average and this is where senior residents, low-income households and non-drivers concentrate (there is, of course, overlap among these three). However, drivers have much longer distances to cover in order to access amenities, and children and youth, many of whom live in households where adults drive, have diminished accessibility to every type of amenity. The latter finding reveals that the SJCMA is not a child-friendly region. In short, the SJCMA seems to be inaccessible as a whole, but it is accessible in certain areas, particularly the most urbanized and older areas of the metropolis – old St. John's – and for certain demographic groups. Furthermore, some types of amenities are more accessible than others. This leads me to conclude that although spatially unequal, the SJCMA is fairly and relatively equitable – those most in need have higher relative access. The next question worth asking is why it is the case that certain areas are more accessible than

others. In the following chapter, I look at the urban form of urban St. John's to attempt to explain this spatial inequality.

Chapter 6 : Analysis, part II: What is the relationship of urban form and accessibility?

In this chapter, I discuss the results of my research by exploring the causes and consequences of the different levels of accessibility in the St. John's CMA. This discussion is focused on the relationship between the city's urban form and the degree of accessibility.

6.1. Urban form and accessibility

A key finding in this research is that accessibility is a matter of location. Not surprisingly, the most urbanized portion of the SJCMA, which contains Central and Downtown St. John's, Mount Pearl, Paradise and parts of Conception Bay South – the four largest municipalities in the metropolitan area – has the highest number of accessible amenities and, thus, the shortest average minimum distances to services and facilities. The old City of St. John's, and its dissemination areas closer to the harbour, has the highest levels of accessibility. However, is it just the age of cities and towns that contribute to their higher accessibility – after all, people had more time to establish businesses in their neighbourhoods – or are there other contributing factors? While the age of a city is certainly a contributing factor, urban form also plays a role.

To study urban form, I compared the DAs that make up pre-war St. John's, hereafter referred to as 'A', and the DAs in post-war St. John's, hereafter referred as 'B'. Following Niemeier and Handy's (1997) method, I used the census-defined urban area to exclude the rural parts of the City of St. John's. In addition, I focus my analysis on a

series of metrics that Lowry and Lowry (2014) conclude correlate highly with urban form differences, as well as additional metrics that I used in this study, such as minimum distance and coverage criteria.. Table 6.1 shows a list of the metrics and the values for A and B.

According to the urban form analysis, after World War II, the City of St. John's began a rapid spatial expansion. Using the Statistics Canada (2006) definition of urban area and excluding areas zoned as open space and airport in the land use map, region 'A' occupies close to 13% of the urban area and region 'B' occupies close to 87%. This result highlights that the urban area of the City of St. John's has expanded 6.56 times its pre-war size. Meanwhile, the increase in land area is accompanied by a decrease of population density, as the density in B is close to half that of A.

Besides size and density, a metric commonly used to determine whether a city is compact or non-compact is its land-use mix. As explored in Chapter 3 and supported by evidence from urban theorists and the Congress for New Urbanism, a city or neighbourhood that has a high mix of uses reduces distance to destinations and, thus, increases accessibility. Region A is much more mixed than region B. The land use analysis used here calculates percentages based on the total area minus open spaces, the St. John's International Airport, and rural areas. The land uses of interest for this study are those that are mixed, such as commercial-residential and commercial-industrial. The former, in particular, is a great measure of compactness and accessibility because it combines households and economic/social activity. Old St. John's has 4.37% of its uses designated as commercial-residential, while post-war St. John's only has 0.14%.

However, the latter region does have a higher mix of commercial-industrial, and this is due to the fact that region B has four large 'power centres' which are usually zoned as the latter designation. As discussed earlier, power centres are now a common sight in the North American urban landscape and represent the latest model of retail geography (Hernandez and Simmons, 2006). The consolidation of economic activity around national chain stores has had a negative impact on both downtown retail, the shape of the city and accessibility. Cities with big box developments have expanded across space, as observed in St. John's. Land zoned for commercial constitutes 9.61% of post-war St. John's. As a final metric of land use mix, I used the amenity mix score system described in Chapter 5. Applying this system to region A and B reveals that the former has an average score per DA of close to 5 types of amenities while the latter has 2.73 types of amenities per DA, which is just above half of A's score.

Another important set of metrics is related to residential development. These include the percentage of land zoned for low-density residential development and the average percentage of single-detached houses. As explored in Chapter 3, a common feature of sprawling urban forms is the high percentage of residential-only neighbourhoods, in particular low-density residences, such as single-detached houses. This type of development attracts a high percentage of homeowners and is, to this day, the preferred mode of living for most Canadians. For the first metric, the lower the value, the more density the area has. Pre-war St. John's has 8.25% of land zoned as residential low density, whereas post-war St. John's has close to 4 times that of region A, making region B much more low density. This value is in agreement with the percentage of single

detached houses in A and B. In pre-war St. John's, 26.51% of the housing stock is composed of single-detached houses. In post-war St. John's, single-detached homes make up 49.72% of the housing stock. Residential neighbourhoods and single-detached houses lead to lower building densities, another metric with a high correlation to urban form (Lowry & Lowry, 2014). My analysis reveals that average building density is more than 1.5 times in pre-war than in post-war St. John's.

Two other metrics that help assess urban form are minimum distance to amenities and schools (Lowry & Lowry, 2014). In the case of pre-war St. John's, the average distance people have to travel to get to the closest amenity is 165.16 meters, while it is 546.94 meters in post-war St. John's. Similarly, the average minimum distance to the closest school is 701.61 meters in region 'A' and 1472.03 meters in region 'B'. The distance that people have to travel to work is also higher in 'B', and this can be inferred from the higher percentage of people working outside of their census subdivision of residence.

Finally, street network connectivity is another important metric used widely in studies on urban form (Oliveira, 2016; Hajrasouliha & Yin, 2015; Lowry & Lowry, 2014; Frank *et al.*, 2005;; Niemeier & Handy, 1997). As mentioned above, streets are a fundamental infrastructure for urban mobility and act as the 'circulatory system' of most cities. One way of comparing two different urban forms is by measuring the average length of the links in a road – the parts of the road delimited by intersections. Road links in pre-war St. John's are, on average, shorter, which means that there is a higher density of intersections, which in turn means that the network is more connected and, thus, it

becomes easier to get to a destination. Pre-war St John's has an average road link length of 98.79 meters, while post-war St. John's has an average road link length of 172.83 meters. This result is logical given that region B is a classic post-war suburban area characterized by curvilinear streets, cul-de-sacs, and a distinct segregation of land uses like car and pedestrian traffic.

Table 6.1. Urban form metrics for pre- and post-war St. John's (ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010a; 2010b; 2008; 2007a; 2007b; City of St. John's, 2006)

	Pre-WWII St. John's (A)	**Post-WWII St. John's (B)**
Approximate area (square km)	7.54	49.05
Mean distance to amenities (per DA)	165.16	546.94
Mean distance to schools (per DA)	701.61	1472.03
Population % working outside of area (average per DA)	8.28%	17.57%
Land use mix (area %)		
Residential	65.52%	37.53%
Residential Low Density	8.25%	32.42%
Mixed Residential+Commercial	4.37%	0.14%
Mixed Industrial+Commercial	1.04%	7.45%
Commercial	5.65%	9.61%
Apartments	1.40%	1.84%
Industrial	4.48%	6.40%
Institutional	9.30%	4.62%
Population density (pop/sqkm)	2417.44	1,812.64
Average Total Amenities (per DA)	18.18	4.03
Average Mix Score (per DA)	4.97	2.73
Average Road Length (m)	98.79	172.83
Average building density (dwellings/square km)	1121.91	718.14
Average % of Single Detached Houses	26.51%	49.72%

The urban form analysis of pre-WWII and post-WWII urban St. John's reveals that there is a relationship between these metrics and the different levels of accessibility

in regions ‘A’ and ‘B’. Furthermore, a closer look at the map of the rest of the urbanized SJCMA (i.e. Mount Pearl, Paradise and parts of Conception Bay South), it can be observed that these commuter towns have similar urban forms as that of post-war urban St. John’s, with the exception of Mount Pearl, which has a higher building and population density in a significantly smaller area than the other communities (see Figure 6.2).

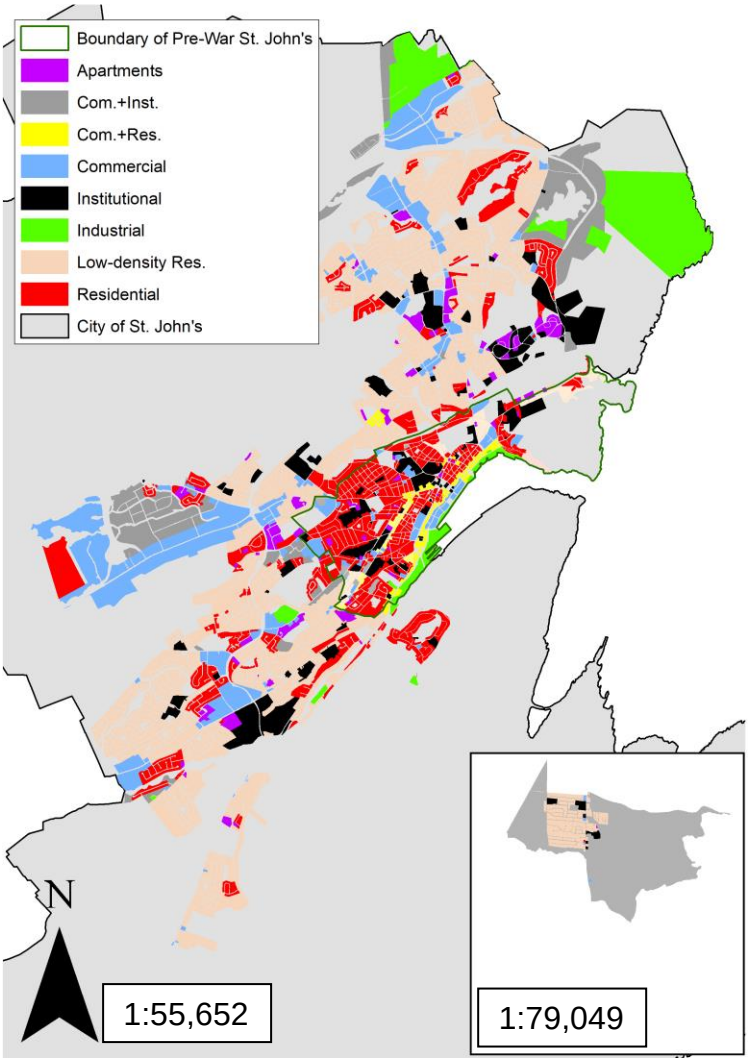


Figure 6.1. Land use map of urban St. John's, 2006 (Source: City of St. John's Planning Department; ESRI; Statistics Canada, 2008)

Mount Pearl also has multiple land uses and a significant portion of the area is zoned as mixed commercial (shown in light purple in Figure 6.2). This is likely the result of relatively rapid intensification as this once small community of 500 acres boomed in the late 1960s in response to a significant population growth (City of Mount Pearl, 2016). Accordingly, the new Municipal Plan adopted in 2010 emphasized intensification and gave the local council the power to deviate from zoning regulations and enable residential intensification projects (City of Mount Pearl, 2010). In fact, the majority of residential zones are now medium density.

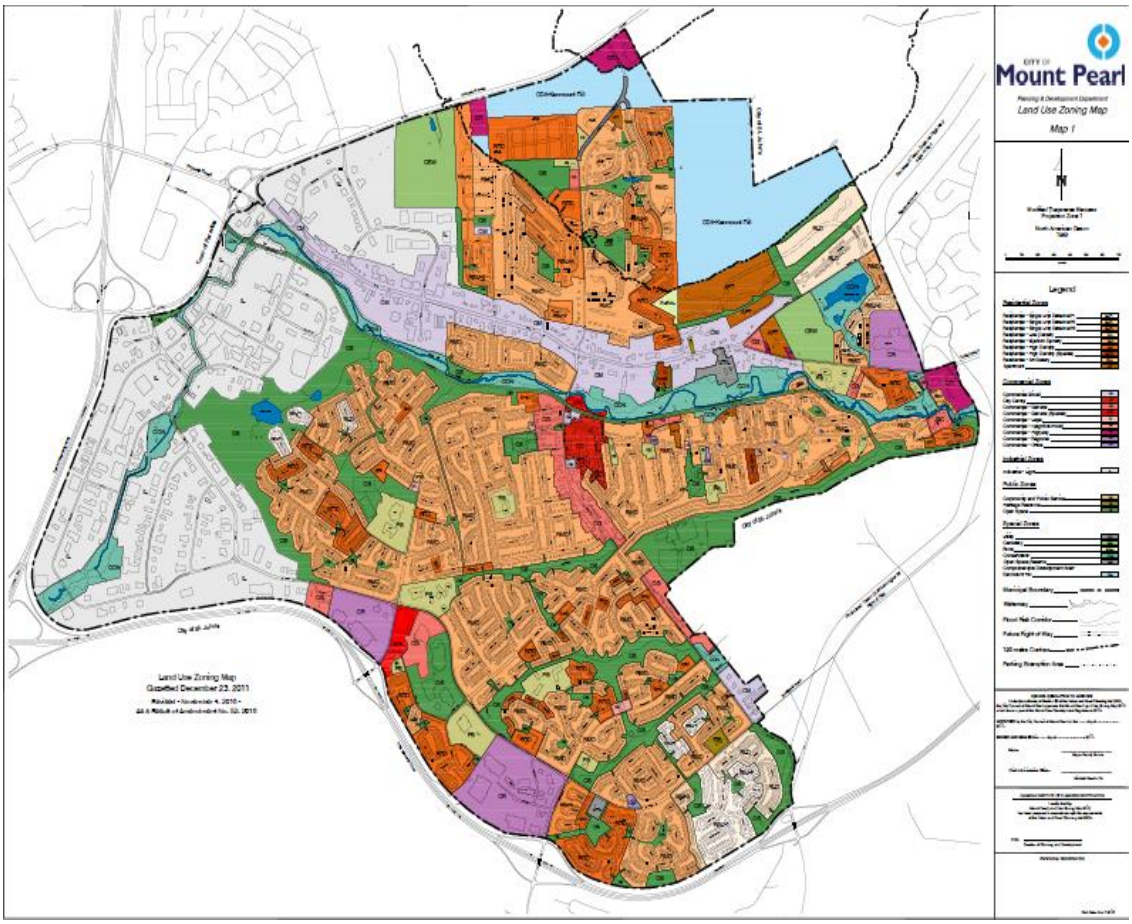


Figure 6.2. Land-use map for the City of Mount Pearl (City of Mount Pearl, 2011)

Other urban communities in the metro area that developed after Mount Pearl are larger in area and smaller in population, hence their much lower densities. Furthermore, there is a sign that people do not want intensification. As Mount Pearl's population has been declining (Statistics Canada, 2008), the adjacent community of Paradise has grown significantly. One reason could be that people moving to Paradise are doing so for the larger parcels of residential land available. But why and how did St. John's and the urbanized SJCMA, in general, become sprawling communities? Part of the answer lies in the role the various levels of government play in urban planning, and, through the visions and enforcement of municipal plans and zoning regulations.

6.2. The devil lies in the details

Much of the sprawl and current urban form of St. John's and the SJCMA can be attributed to an emphasis on 'vertical planning,' a practice that has come to encourage low-density and segregated development after the first significant expansion of the City of St. John's in the 1940s. The first major urban development, which was enacted by the provincial bureaucracy, was Churchill Park garden suburb. Churchill Park became a leading model for suburbanization in St. John's and it was a government agency – the St. John's Housing Corporation – who designed, promoted and executed the development project. From the first days of suburbanization and the drafting and adoption of the City's first Municipal Plan in 1984, planning policy in the province has since encouraged non-compact development, in the form of low-density residential neighbourhoods with single-detached houses, streets with long setbacks, strict minimum parking requirements, and

amalgamation (see City of St. John's Development Regulations, 1984; City of St. John's Development Regulations, 1994). Despite setting objectives to the contrary, planning culture in St. John's has been regressive from the beginning.

This vertical planning practice, in which the government and the development industry work together with little to no public consultation and where planners have a diminished voice, has significantly deepened sprawl throughout the region. One reason is that local councils across the metro area assume that most people want low-density housing and zone most areas for it, making single detached houses the most common form of housing.

Indeed, my research found that 56% of the housing stock in the Metro area is single-detached dwellings, a value that has been constant for the previous 5 years, and represents an increase of 2 percent over the previous 10 years (Statistics Canada, 2002; 1998). Despite a drop in the metropolitan population from 1996 to 2001, the number of single detached homes increased by more than 4,000, while the number of duplexes decreased by 600. Low-density promotes 'leapfrog' and scattered development and increases the distances that people have to travel to get to their destination. It is true that Canadians have largely preferred this way of living for over six decades, making the St. John's story no exception (Statistics Canada, 2017; Grant, 2001), but it is also the responsibility of municipalities to set the path to denser and more sustainable urban forms. A way to do this is to focus on the "missing middle housing," which includes duplexes, fourplexes, live-work units and other types of clustered housing units that both offer spacious living and help increase densities and accessibility (Parolek, 2014).

Transportation is another key factor playing a role in the intensification of sprawl throughout St. John's and its metro area. In 2006, the car was the main mode of transportation for 87% of working age adults (Statistics Canada, 2008), a slight drop from 90% in 2001 (Statistics Canada, 2002). Even considering the drop, a great majority of the metropolitan population prioritizes automobility, especially those living further from the city centre. At present, car travel is the most convenient mode of transportation in the region since investments on infrastructure and minimal road congestion have combined to increase overall automobile affordability and convenience. We must also add to this the low cost of parking in the city and region, a priority that is underlined in local municipal plans and enforced through zoning by-laws and land-use strategies (Dillon Consulting, 2011).

Considering the role of the car in St. John's, comprehensive public transit represents an important solution to sprawl. Indeed, as reviewed in Chapter 3, a more accessible and extensive bus transit system can dramatically reduce the needs of parking space, encourage transit-oriented development (TOD), lead to higher density living around transit hubs, increase accessibility for low-income residents and those living in poverty and, generally, augment quality of life (Loo *et al.*, 2010; Marans & Stimson, 2011; Glaeser *et al.*, 2008a; Punter, 2006; Shoup, 1999; 1997). As is well known, the present St. John's public transit system is sub-standard (Dillon Consulting, 2011). Reasons abound: first, Metrobus, the local bus system, receives limited public funding; second, land use in the SJCMA discourages both investment in transit by municipalities and expansion of the service by Metrobus. Most of the SJCMA is non-compact, and most

new and projected land development is low-density, making any potential expansion of transit service highly cost-ineffective (Dillon Consulting, 2011).

Low-density, segregated land development and car use reinforce each other, causing higher sprawl. To be sure, business benefits from and it often exacerbates sprawl. The best example of this relationship is the development of 'power retail' like the 'big box' phenomena. Here, big box retail is supported by the convenience of easy access from the highway and free parking for drivers (Hernandez and Simmons, 2006; Collins, 2004; Shoup, 1999). 'Big boxes' and 'power retail' have drastically shaped the retail landscape and the urban form of St. John`s and the SJCMA over the last 20 years. One clear example is the power centre at Stavanger Drive, located in close proximity to the St. John's International Airport, north of the city. Stavanger Drive is the largest big box development in the province (Collins, 2004) which began in the early 1990s. Despite local opposition (Collins, 2004), the city passed the rezoning proposal in early 2000s. The development changed hands and soon began expanding rapidly. Accompanied by a construction of the Outer Ring Road, traffic in the area increased significantly and has made this commercial development one of the busiest in the province.

The Stavanger retail development is an important example of the impact that planning and land use decisions make on accessibility. Approving and zoning for large commercial developments in the periphery of cities negatively impacts the downtown area significantly, where commercial activity is much more accessible, in particular for people who do not drive. Power retail developments, like Stavanger Drive, not only pay lower rents per square meter, which allows them to offer lower prices, but also have

much larger parking capacity. Downtown retail stores lack these advantages and thus lose customers to big boxes (Hernandez and Simmons, 2006; Malone Giren Parsons Ltd., 1990). Stavanger has meant less business for St. John's core areas and other neighbourhoods in Central St. John's. This has been worsened by the rapid increase in retail floor area in the whole city, creating an oversupply of stores. In 1990, the year where big boxes began to take hold, St. John's had approximately 2 million square feet of retail area. Close to 23% was located in the downtown area. Village Mall alone had slightly more floor area than all of downtown combined, and Avalon Mall's footage represented 17.5% (Malone Giren Parsons Ltd., 1990). Kelsey Drive and Stavanger Drive, the newest consolidated retail developments, have only made matters worse.

To this day, big boxes drive tens of thousands of consumers on a daily basis, while commercial vacancy has expanded through the downtown core. In July 2017, MacEachern (2017) reported that 20.3% of downtown space sat empty, compared to a vacancy rate of 3.8% only two years prior. Reasons listed include a slowdown of the economy due to falling oil prices, but also the fact that the downtown and other areas in Central St. John's, such as Churchill Park, have lost anchor businesses and institutions, vital for their continuing existence. Specifically, Suncor left the Scotia Centre on Water St. for a business park in Kelsey Drive, leaving 60,000 square feet vacant (Roberts, 2016). A key reason cited was the lack of parking space in the city. Put simply, cars drive this economy, but top-down decisions from city council and the provincial government have exacerbated this issue.

At the moment, the downtown area is dying out, but there are solutions, and they lie precisely in progressive urban policy that is cognizant of citizens' needs, including their equitable accessibility to services and facilities. A development strategy commissioned by the City of St. John's in the 1990s (Malone Giren Parsons Ltd., 1990) suggested that council make an explicit link between the harbour and the downtown commercial area; draft new policies to protect the downtown commercial future; and reduce segregation of land uses in the downtown area. Indeed, mixing land uses and protecting business in the core areas of the city via innovative policies, such as heritage preservation, may be key to putting St. John's back in the track towards compactness, accessibility and livability.

Amending the policy landscape and changing the planning culture is fundamental to the future viability of St. John's as a city. Ultimately, the problem is more systemic than it may seem – sensible urban planning and design has been overshadowed by a thirst for economic growth and tax revenue. As explored in Chapter 3, neoliberalism and corporate interests have upended municipal governance (Brenner *et al.,* 2012; Harvey, 2012). The private sector has become highly influential in city councils and municipal governments, turning city planning into a short-term business deal, in which projects have little to no oversight (Grant, 2001). As an example, when changes in the Stavanger Drive development were approved by the City, there was no planning policy in place to regulate and manage its growth. Indeed, while the 1994 Municipal Plan explicitly required an evaluation of future economic impact of new and existing retail, the most recent Municipal Plan (2003) removed that requirement. Perhaps more to the point,

Stavanger Drive is considered as a ‘Planned Unit Development’, which gives significant decision-making power to the developer and a case where sustainable and accessible design, including transit linkages, is left by the wayside in an effort to reduce costs. The public and the locally-based economy are ultimately the victims.

Chapter 7 Conclusion: The ideal vs the real city

Through a descriptive and comprehensive evaluation of accessibility to six types of basic amenities in the St. John's Metropolitan Area, I found that the SJCMA is inaccessible to the average pedestrian. However, there is a complex geography to accessibility as different neighbourhoods and demographic groups experience varying levels of access. In other words, accessibility in the region is unequal, but it is also relatively equitable – the groups most in need of amenities have higher access to them. These two realities also changed according to the type of amenity.

While this thesis begins to answer the question of what role urban form plays in accessibility, my findings reveal that, on a descriptive level, there is a strong relationship between the two variables. The historical development and planning of St. John's plays a significant role in defining what I consider as distinct geographical accessibilities: while the old city of St. John's is much more compact, the newer and more suburban city prioritizes automobility and a decentralized way of life. This way of life has expanded across the metropolitan area. It is worth considering here, however, that only census data from 2006 was included in this analysis. In light of the economic downturn of 2008 and the effects it has had on Downtown St. John's and its retention of business and amenities, the current reality of accessibility in the SJCMA may be quite different. Even if the Downtown is more compact, it may have much lower levels of accessibility nowadays than other areas in the metropolitan area.

Geographers and planners have for years debated and explored the shape and consequence of urban decentralization and sprawl. Little research, however, has focussed

on the case of St. John's. As a corrective to this lacuna, my research provides some clarity to this context. In particular, this research demonstrates that there is an ever-widening gap between vision and policy, between ideal and real planning. On the one hand, the visions of regional and municipal plans in the SJCMA and the City of St. John's suggest that the governing bodies in charge of enforcing land development regulations were and are forward-looking. Historically, regional planning in the SJCMA was regulated by the St. John's Metropolitan Area Board (SJMAB, established in 1963) and overseen by the NL Minister of Municipal Affairs (NL Assembly, 2000). The SJMAB was dissolved in 1991, when a series of amalgamations took place, significantly reducing the number of municipalities. But in the time before its dissolution, the SJMAB drafted and implemented the St. John's Urban Region Regional Plan in 1976 (NL Department of Municipal Affairs and Housing, 1976). The plan's vision was to transform the region into a livable place, extending public services to all areas efficiently, preserving natural ecosystems, and veering away from 'ribbon' development and towards intensification and concentrated development within the established urban axis – St. John's-Mount Pearl/New Town-Conception Bay. Furthermore, part of its vision aimed at recognizing the St. John's-Mount Pearl belt as the regional centre of the SJCMA, to allow all types of land uses in this centre, and to protect the heritage of the old-historic city core.

Addendums in 1977 doubled down on intensification, infilling and concentrated development, and stated that land uses should include the whole range of residential densities and commercial, cultural, and industrial facilities (NL Department of Municipal

Affairs and Housing, 1977). For instance, the SJURRP explicitly prohibits ribbon development along major arteries of the metropolis, with exceptions for infilling projects in areas already developed (NL Department of Municipal Affairs and Housing, 1977, 16). The Plan even warned that people who want to live in rural areas or adjacent to open space and who do not rely on the cities for municipal services, still make their living from employment in the urban core, in an attempt to highlight the importance of the urban core.

Overall, the SJMAB is largely inconsistent: while it simultaneously seeks to bolster centrality, its policies encourage decentralization. These policies encourage low density residential development within local centres, such as Bauline and St. Phillips, with the distinct separation of commercial, residential, and industrial land uses.

For the City of St. John's, planning is guided by the Municipal Plan and enforced by the Development Regulations. The Development Regulations currently in place were adopted in 1994 (City of St. John's, 1994). Under the heading "Urban Form," the Municipal Plan's

> …broadest objective of land use policies is to facilitate an efficient pattern of development. Generally, this means building a compact city" made possible by "shorter distances to travel to work and shopping, car trips are reduced and transit use is facilitated. (City of St. John's, 2003; p. 20).

The plan's objectives also include the increasing of density in residential developments, the mixture of land uses, and the reduction of automobile use through better land use planning.

As with the SJURRP, the Municipal Plan has clear inconsistencies. Its objective is to increase residential density, but a 1984 background report before the adoption of the first Municipal Plan was very clear in its aim to reduce residential densities – citing neighbourhood character preservation as a key reason – separate commercial and residential to minimize conflicts, and replace high residential zoning with a new zone called "Residential Medium Density – *having a Potential for Higher Density*" (Johnson, 1984, p. 10). The 2003 plan states: "Only sites located on or near an arterial road, close to commercial services, recreational facilities, and open space would qualify for such use." (City of St. John's, 2003, p. 29). The plan also permits the construction of single detached dwellings in residential medium density zones (City of St. John's, 2003), thus letting low-density type developments extend beyond their own zoning.

In the case of commercial developments, the municipal plan states that "it is necessary and desirable to place commercial close to developed residential neighbourhoods" (City of St. John's, 2003, p. 32), thereby encouraging mixed use. But the reality is that this objective is hardly accomplished. Most commercial development in St. John's is zoned as 'Commercial General' (CG), which encompasses developments that are located in *selected* areas, encouraging segregation and consolidation of one single land use into regional shopping centres of more than 10,000 m^2. Given the current economic climate and the steady decline in local commercial and retail, it is surprising that this policy has not been amended, but it is safe to say that this may be partially due to the power developers wield.

Beyond the retail policy landscape, ‘commercial highway’ (CH) is another land use that encourages sprawl and automobile use. The CH policies increase the convenience of drivers by allowing businesses to place driveways and parking by the side of the road and selling their products via a drive-thru. In that way, drivers do not even need to get out of their cars to purchase goods.

Lastly, the land use category of ‘commercial neighbourhood’ (CN) sets broadly defined compatibility requirements for commercial developments in this zone, most of which are small businesses. It requires developments to be compatible with nearby residences and it can easily lead to denial of business permits if a household is not pleased with a new store. Furthermore, CN only includes businesses in private residences, offices, and convenience stores or related shops. With this regulation, larger grocery stores that may provide healthier and more affordable food are actively discouraged.

Other examples seen in the 1994 Development Regulations dictate that drive-thru facilities must be at least 150 meters away from any residential zone, apartment zone, schools, day care centers or churches (City of St. John’s, 1994, p. 78). There are strict regulations for residential retail and convenience stores. There is a long list of parking requirements for each type of building. Residential buildings, for example, must have one parking space per dwelling unit and restaurants must have one parking space per $5m^2$, an incredibly large amount of space (City of St. John’s, 1994, p. 88).

While there is much to celebrate in St. John’s long history, the city has received considerable criticism over the years by urban historians, planners, urban experts,

scholars and the public. Some of these critics have argued that the municipal government position on planning was largely reactive, on a project by project basis, and was guided by physical development parameters rather than by a more holistic approach (Denhez *et al*. 2000a; 2000b). What is more, the City of St. John's itself (1996) questioned the many residential land-use districts; its 'developer-friendly' approach; and the lack of focus and push for mixed use and transit-oriented high-density development. There is also criticism found in terms of the oversupply of retail floor area, strict setback, lot minimum and parking minimum requirements (A.J. Diamond Planners Ltd., 1980).

In short, strategic planning policy in St. John's and its surrounding communities in the SJCMA is not only weak, but has opened the door to a planning culture that privileges suburbanization and sprawl in a time where centralization, compactness and walkability are lauded as part of progressive and sustainable urban futures (Ewing & Hamidi, 2015; Montgomery, 2013; Ewing *et al.*, 2006; Jabareen, 2006; Punter, 2003; Olderburg, 1989; Jacobs & Appleyard, 1987). If the population of the province and the SJCMA is close to its peak and soon will start falling (Simms and Ward, 2017), then why are local municipalities delaying action instead of planning proactively?

I believe that there is hope. The recent shake up in the local council is one example where a culture-shift is taking place through a focus on accessibility and 'good' urban design. Moreover, in 2014, the City of St. John's released a draft for a new municipal plan called *Envision St. John's Municipal Plan* (City of St. John's, 2014) wherein St. John's is envisioned with 'complete' neighbourhoods and quality urban design: "There [is]… recognition that a greater mix of uses and higher density residential

development will be required to support such initiatives" (City of St. John's, 2014, p. 13). The City wants people to be able to access goods and services within walking distance along complete and interconnected streets. A way for the city to enable more complete neighbourhoods is through its proposed New Planned Mixed Development Zones, which will complement the existing mixed-use zones in areas adequate for infilling and rehabilitation, so the new project in place follows a complete mixed design.

Recent research on accessibility has made important contributions to the scholarship on urban studies and planning. Besides offering new methodological lenses that reveal material and physical challenges in the city, this research has shed light on the rising inequality of urban lifestyles inherent in the contemporary, largely decentralized, city. Clearly, one of the key factors in developing cities for all is striving for accessibility. Since World War II, most Canadian cities have been redefined without accessibility as a central priority and this has resulted not only in aggravating socioeconomic inequality but also a trend of city governments neglecting their urban minorities, including those that have mobility challenges. In the SJCMA, children and youth (people aged 0 to 14) are the most affected by the lack of accessibility. This problem is global, but child-friendly cities are a response by municipalities and urbanites to recognize children's place in cities and their right to urban spaces.

This research is the first step in evaluating sustainable and inclusive access to services and goods in the city. Children's lack of accessibility, as well as that of other demographic groups, can be further evaluated qualitatively, through interviews and focus groups. In particular, the methodology and the data I used to carry out this research has

its limitations. First, results on accessibility depend in great part of the availability of information found on map files of the street network in St. John's, which lacks certain features, such as pedestrian connectors that may have been built but not integrated into government files. Second, as in other studies in the accessibility literature, future extensions of this research, which relies almost exclusively on quantitative methods and spatial analysis, could be highly enriched by taking full advantage of the broad repertoire of qualitative methods. These methods can help reveal with more precision the true struggles in reaching facilities and spaces that certain groups of people experience on a daily basis. Whereas accessibility is highly sensitive to scale – a few meters can make a significant difference – GIS methods undertaken in this research have the particular limitation of excessively aggregating data to larger scales, thereby distorting true levels of (in)accessibility. Qualitative methods, paired with quantitative analysis, can help disaggregate data.

Broadening the menu of methodologies in accessibility studies would not only be beneficial to the goals of this thesis and of future studies, but it would also greatly benefit the bigger goals of municipalities across the world, in particular small and medium-sized cities, which need to attract people to grow their economies. Municipalities can learn from these studies and consider the findings in their municipal plans and other pieces of planning legislation. Qualitative methods could inform planners and agencies on how certain changes to urban design guidelines and zoning regulations could enhance citizens' experience of the city. There are cities that have made significant progress in reaching universal access, and there is still much to do to create more inclusive cities. With that

said, more studies on smaller cities can add to the growing literature on the urban periphery, perhaps revealing new dimensions of accessibility, spatial equity and urban form in small and medium-sized agglomerations.

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D=0&GK=0&GRP=1&PID=94534&PRID=0&PTYPE=89103&S=0&SHOWALL=No&SUB=0&Temporal=2006&THEME=81&VID=0&VNAMEE=&VNAMEF= (accessed May 1, 2016)

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Appendices

The appendices include the results for accessibility values under coverage criterion I, II and III as well as Euclidean and network minimum distances, as described in Chapter 4; and includes additional data for accessibility to different types of amenities for various demographic groups. The appendices are divided into 6 sections, with the first three presenting the three coverage criteria; section 4 and 5 presenting the two minimum distance measures; and the last section includes accessibility to six types of amenities by five demographic groups.

1. Coverage criterion I (CCI)

1.1. All amenities in the SJCMA (CCI)

A count of all amenities by dissemination area, which includes every type of service, facility and space with an assigned NAICS code, was undertaken within the metropolitan area. In 2010, the total number of surveyed entities (this includes businesses, non-profit organizations, public institutions, religious groups, etc.) by the database used for this research, InfoCanada©, was 6,990. The City of St. John's had 5,032 (~72%) of total registered entities in 2010; the City of Mount Pearl had 1,054 (15%); the Town of Conception Bay South had 270 registered entities (~4%); and the Town of Paradise had 261 (3.7%). Table A.1 shows total number of registries from InfoCanada for SJCMA and the largest census agglomerations in 2010.

Table A.1. InfoCanada registries by census subdivision, SJCMA, 2010 (Soure: InfoCanada, 2010; Statistics Canada, 2010b; ESRI 2015)

	Registries in 2010
SJCMA	6,990
St. John`s	5,032
Mt. Pearl	1,054
Conception Bay South (CBS)	270
Paradise	261

An analysis of total amenities for the six types of amenities chosen for this research (schools, grocery stores, and recreational, health, nursing and child care amenities) shows an unequal spatial distribution in 2010 in the SJCMA, with dissemination areas in the north and south having zero amenities and with most amenities concentrated in the eastern portion of the CMA, particularly in Mount Pearl and St. John's (see Figure A.2 for a map of the distribution of amenities in 2010). The cities of St. John's and Mount Pearl (inset map in Figure A.2) show higher concentrations of amenities than the rest of the CMA, with the downtown area of St. John's around the harbour presenting the highest concentration of amenities.

This analysis also reveals that, in 2010, there were a total of 848 amenities of *all* 6 types of amenities, while there were 201 DAs with at least one amenity and 117 DAs without any amenities (see Table A.2 and Figure A.1). The average number of amenities under the coverage criterion I (CCI) is 2.59 amenities per DA, while the median is 1 amenity per DA. The maximum number of amenities found in a single DA is 31.

Table A.2. Descriptive statistics for amenities under coverage criterion I, 2010 (Source: ESRI 2015, InfoCanada 2010; Statistics Canada, 2007a)

	Total	DAs with amenities	DAs without amenities	Mean	STDEV	Median	Max	Min
All Types	848	201	117	2.67	4.55	1	31	0

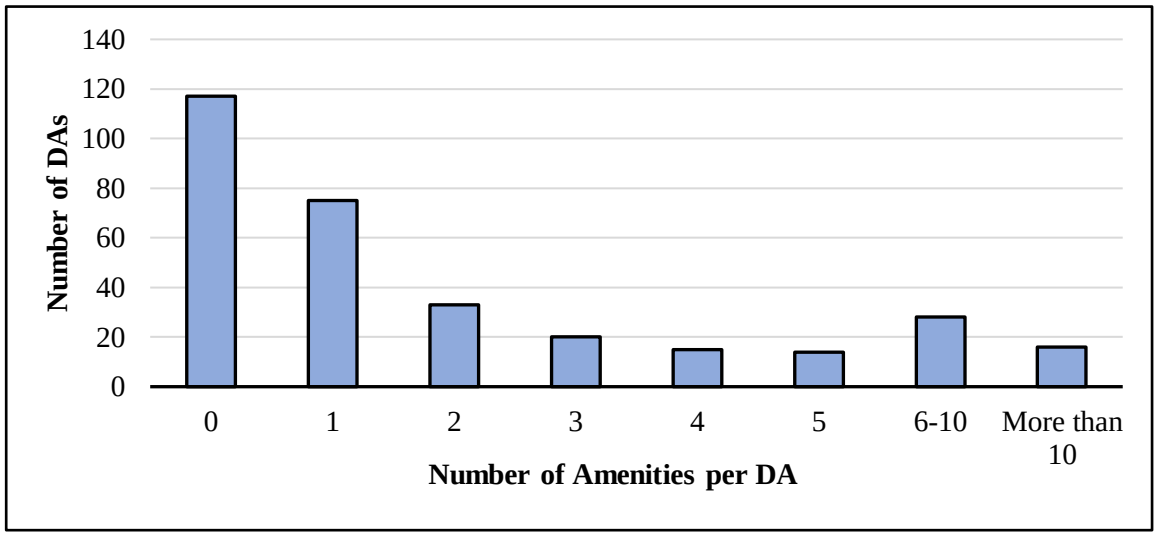


Figure A.1. Dissemination areas by average number of amenities per DA, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2007a)

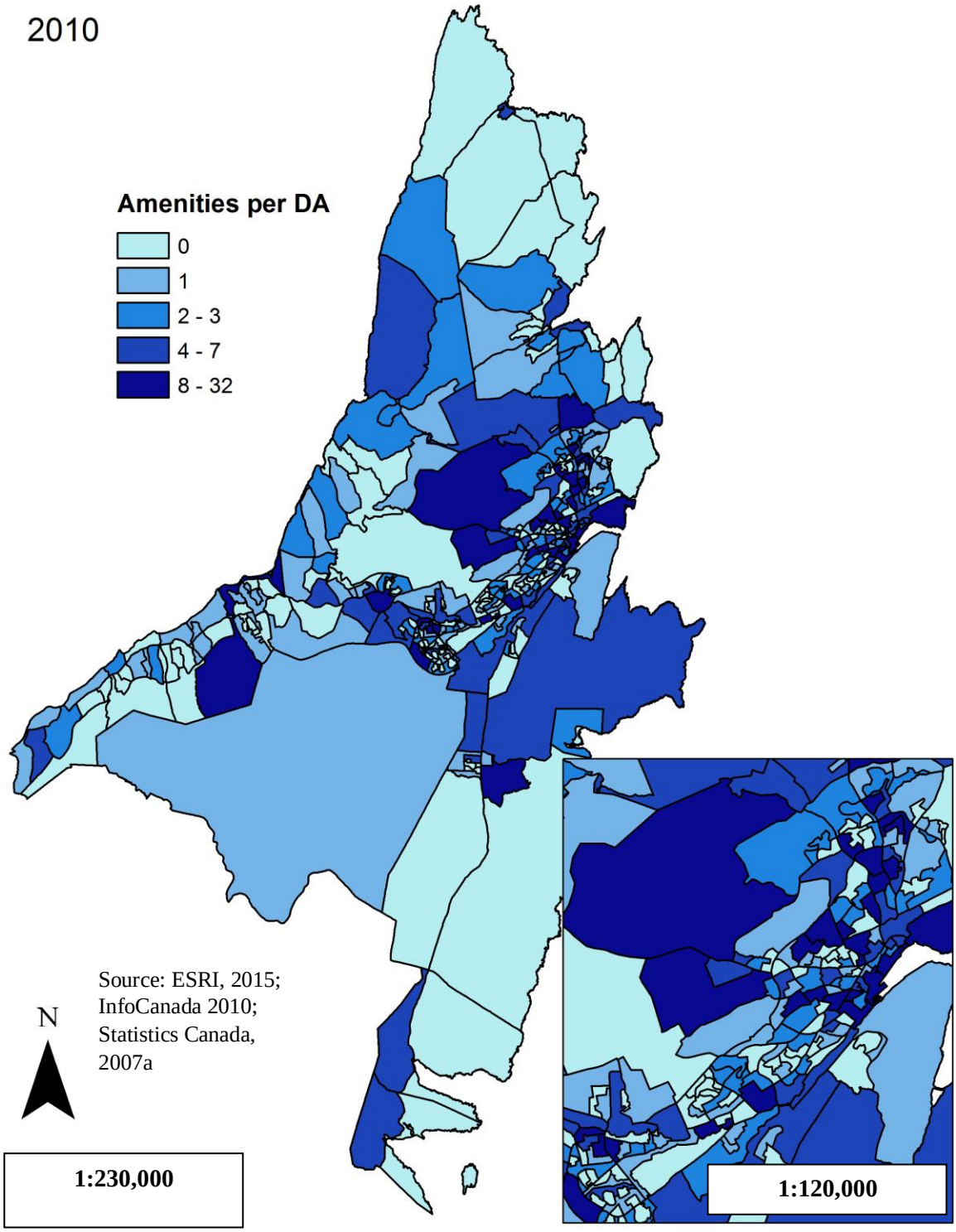


Figure A.2. Amenities (6 types) by DA in SJCMA in 2010

1.2. Amenities by type (CCI)

All six types of amenities

A general comparison among the 6 types of amenities selected for this study is shown in Figure A.3 and Table A.3, which contains descriptive statistics for all amenities and each type of amenity under CCI for 2010. As it can be observed in Figure A.3, health amenities represent the largest portion of all of the 6 analyzed types of amenity, followed by recreational amenities. The amenities with the lowest number of registries corresponded to nursing care services. It is worth noting that there is a similar number of schools and childcare amenities. In addition, it logically follows that if amenities are evenly distributed, the more services for a given amenity, the higher the number of DAs with at least one amenity. This is mostly the case for 2010, except for the top two amenities, with recreational facilities enjoying a more even spatial distribution (95 DAs with at least one amenity) than health amenities (94 DAs).

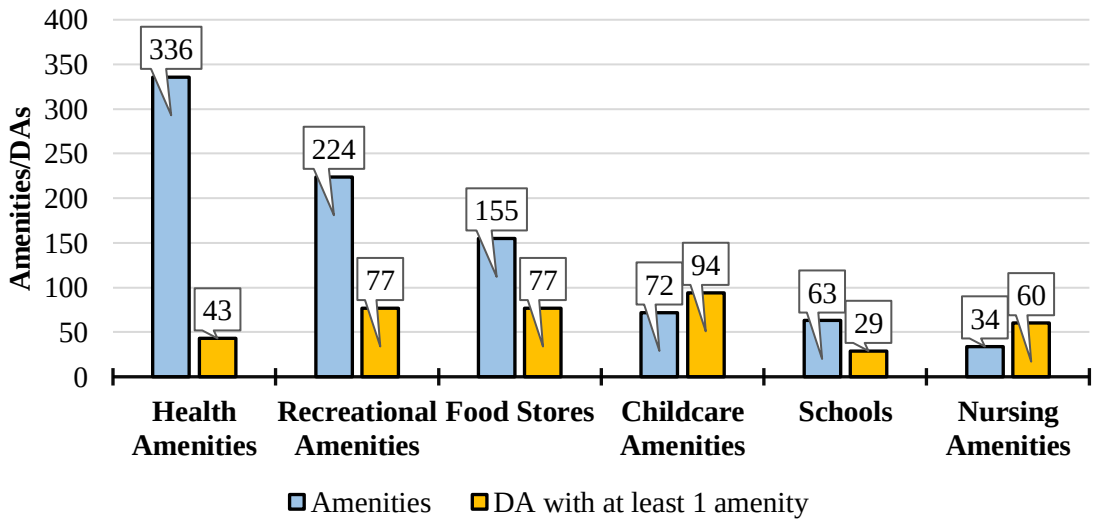


Figure A.3. Total number of amenities across the SJCMA for each type of amenity in 2010 (Source: ESRI, 2015, InfoCanada, 2010; Statistics Canada, 2007a)

Table A.3. Descriptive statistics for all amenities and amenities by type in the SJCMA in 2010 (Source: ESRI, 2015, InfoCanada, 2010; Statistics Canada, 2007a)

	Total	DAs w*	DAs wo*	Mean	STDEV	Median	Max	Min
All Types	848	201	117	2.67	4.55	1	31	0
Recreational Amenities	224	95	223	0.70	2.08	0	24	0
Health Amenities	336	94	224	1.06	2.51	0	19	0
Food Stores	155	77	241	0.49	0.81	0	5	0
Childcare Amenities	72	60	258	0.23	0.51	0	3	0
Schools	63	43	275	0.20	0.56	0	4	0
Nursing Amenities	34	29	289	0.11	0.37	0	3	0

*with amenities; without amenities

1.3. Amenity Mix (CCI)

Amenity mix scores were calculated for each of the 318 DAs in the SJCMA in 2010. Figure A.4 shows the number of DAs by mix score and the average number of amenities per DA. A clear observation from the graph is that the higher the mix score, the higher the average number of amenities and the lower the number of DAs. The majority of DAs in 2010 have no amenities (117). Most of the DAs with amenities have a mix score of 1 (85). Figure A.5 shows a map of the distribution of mix scores per DA. The distribution follows a similar pattern as that of the total number of amenities. There is a concentration of higher mix scores in the eastern portion of the metropolitan area, but there are also pockets of concentration in the west (Portugal Cove-St. Phillips) and the south (CBS, Bay Bulls and Witless Bay). Generally, the northern DAs have lower mix scores.

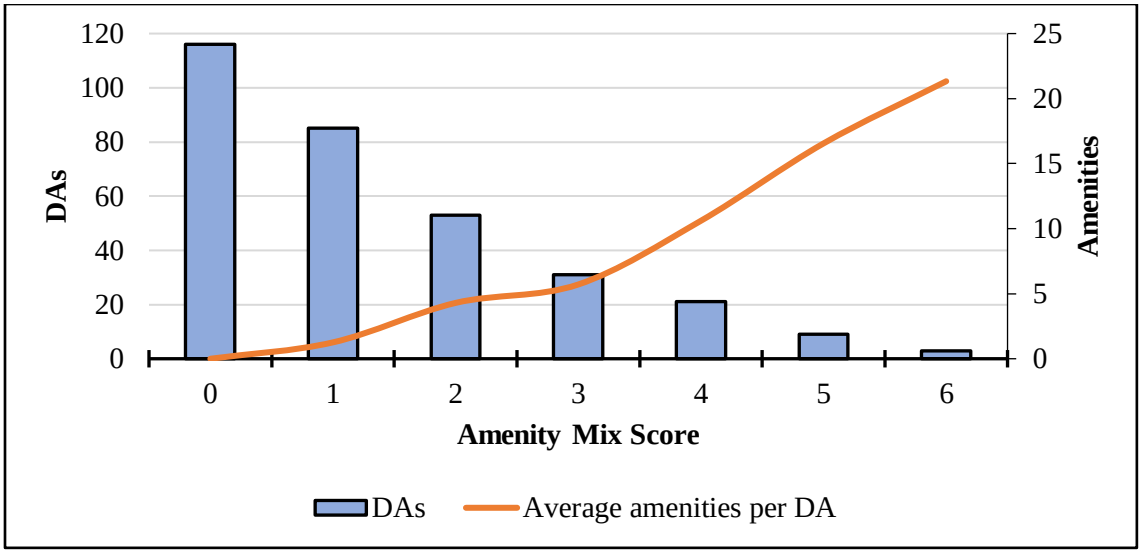


Figure A.4. Average DAs and amenities by mix score, SJCMA, 2010 (Source: ESRI, 2015, InfoCanada, 2010; Statistics Canada, 2007a)

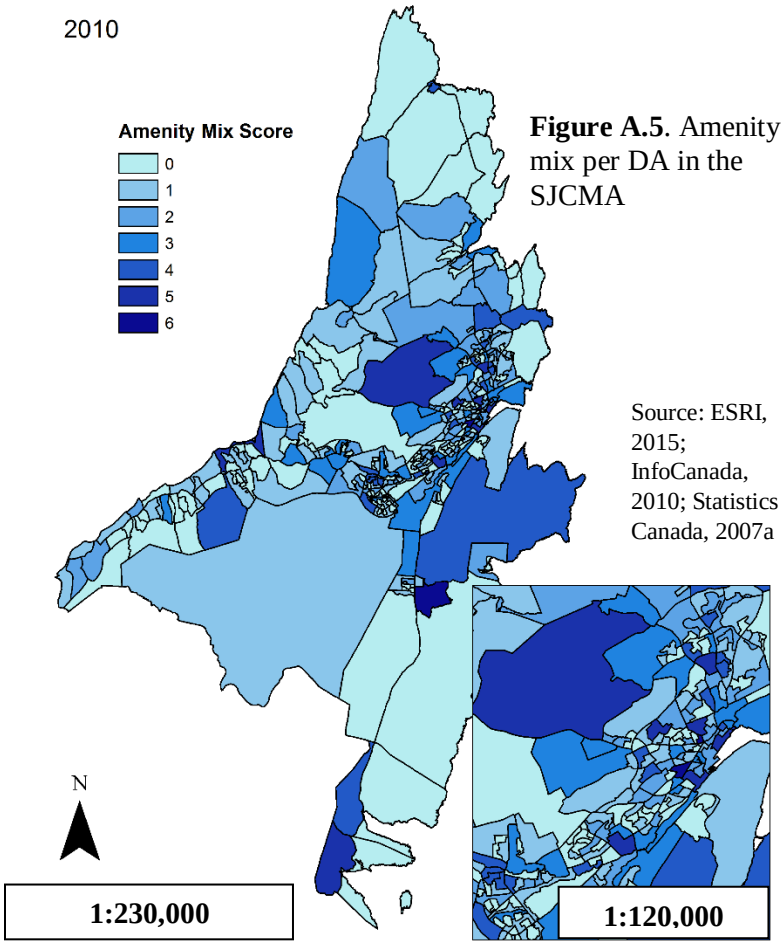


Figure A.5. Amenity mix per DA in the SJCMA

Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2007a

DAs with a mix score of 6

Out of the 318 DAs in 2010, only 3 had an amenity mix score of 6, containing at least one amenity of each of the 6 types chosen for this study. These DAs are located in Central St. John's, right on the periphery with Downtown St. John's, as well as Goulds, a rural town south of downtown that was amalgamated into the City of St. John's in 1991 (Collier, 2011) (see Figure A.6 for a map with the location of the three DAs). The areas contained by the three DAs correspond to mixed-use neighbourhoods, with anchor amenities (e.g. St. Clare's Hospital, Royal Constabulary of Newfoundland, and downtown Goulds).

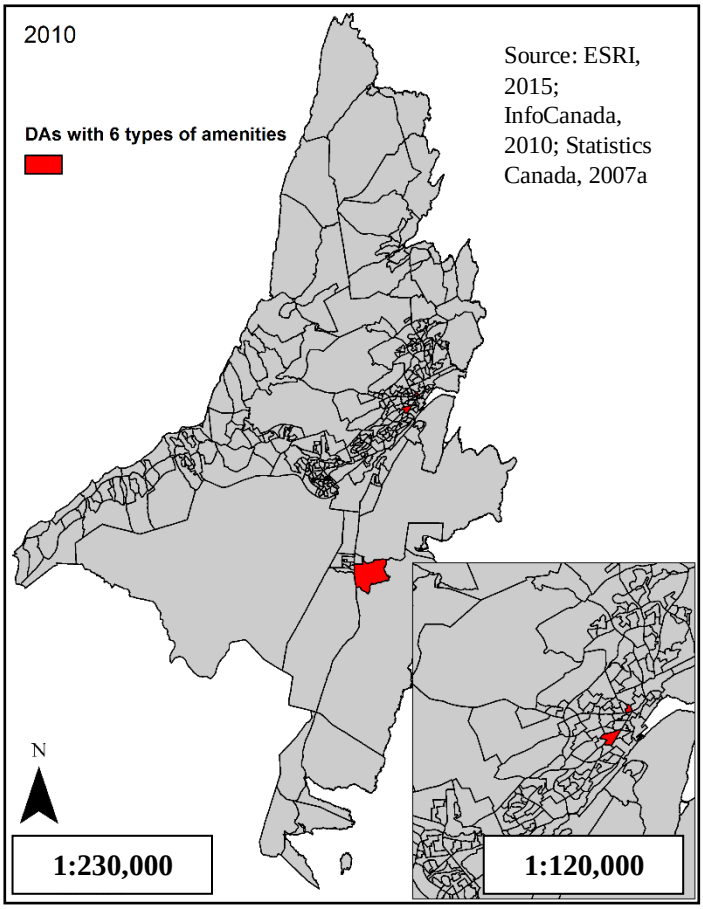


Figure A.6. DAs with mix scores of 6, in SJCMA, in 2010

2. Coverage criterion II (CCII)

Accessibility under the coverage criterion is more accurate when a buffer area of a certain distance from the point of origin to the amenity is generated. In this case, a buffer area is drawn around the point of origin – the DA centroid – with a radius of 500m. The number of amenities within that buffer area is counted for the six types of amenities selected for this study.

2.1. All amenities in the SJCMA (CCII)

The second accessibility assessment was conducted by counting amenities within 500-meter buffer areas, generated with the DA centroid as point of origin and the amenity (service/facility) as point of destination. This method is considered part of the coverage criteria (CC) as it counts amenities within a confined area, which in this case is a 500-meter buffer, considered to be the maximum distance for a 10-minute walk (refer to the Methods chapter for a more detailed description on the 500-m standard). As with CCI, CCII was undertaken for the whole St. John's census metropolitan area.

Compared to CCI, an evaluation for all the six types of amenities under CCII shows a much more unequal spatial distribution across the SJCMA, as most DAs with accessible amenities are concentrated along a 'belt' of accessibility, coinciding with the more urbanized areas of the metropolis (Central and Downtown St. John's and Mount Pearl, for the most part, and Torbay, Paradise and CBS, to some extent). DAs in the north and south of the CMA outside of the belt have no accessible amenities (see Figure A.7 for a map of the distribution of amenities under CCII in 2010). Downtown and Central St.

John's as well as Mount Pearl (inset map in Figure A.7) show the highest concentrations of amenities, particularly in DAs closest to the harbour. There is, in addition, an observable variation in concentration of amenities in the urban core of the city of St. John's. There is a clear divide between southwestern and northeastern areas. The northeastern section of the urban core has a much denser concentration of DAs with 20 or more amenities – areas in dark blue in the map – while the southwest contains many more areas with lighter blue.

This analysis also reveals that there was a total of 729 amenities (of all 6 types) contained within buffer areas, while there were 220 DAs with at least one accessible amenity and 98 DAs without any accessible amenities (see Table A.4). The average number of amenities that were accessible from a DA centroid is 8.05 amenities, while the median is 3 amenities per DA. The maximum number of accessible amenities for a single DA was 66.

Table A.4. Descriptive statistics for amenities under coverage criterion II, 2010 (Source: ESRI, 2015, InfoCanada, 2010; Statistics Canada, 2007a)

	DAs w*	DAs wo*	Mean	STDEV	Median	Max	Min
CCII	220	98	8.05	12.21	3	66	0

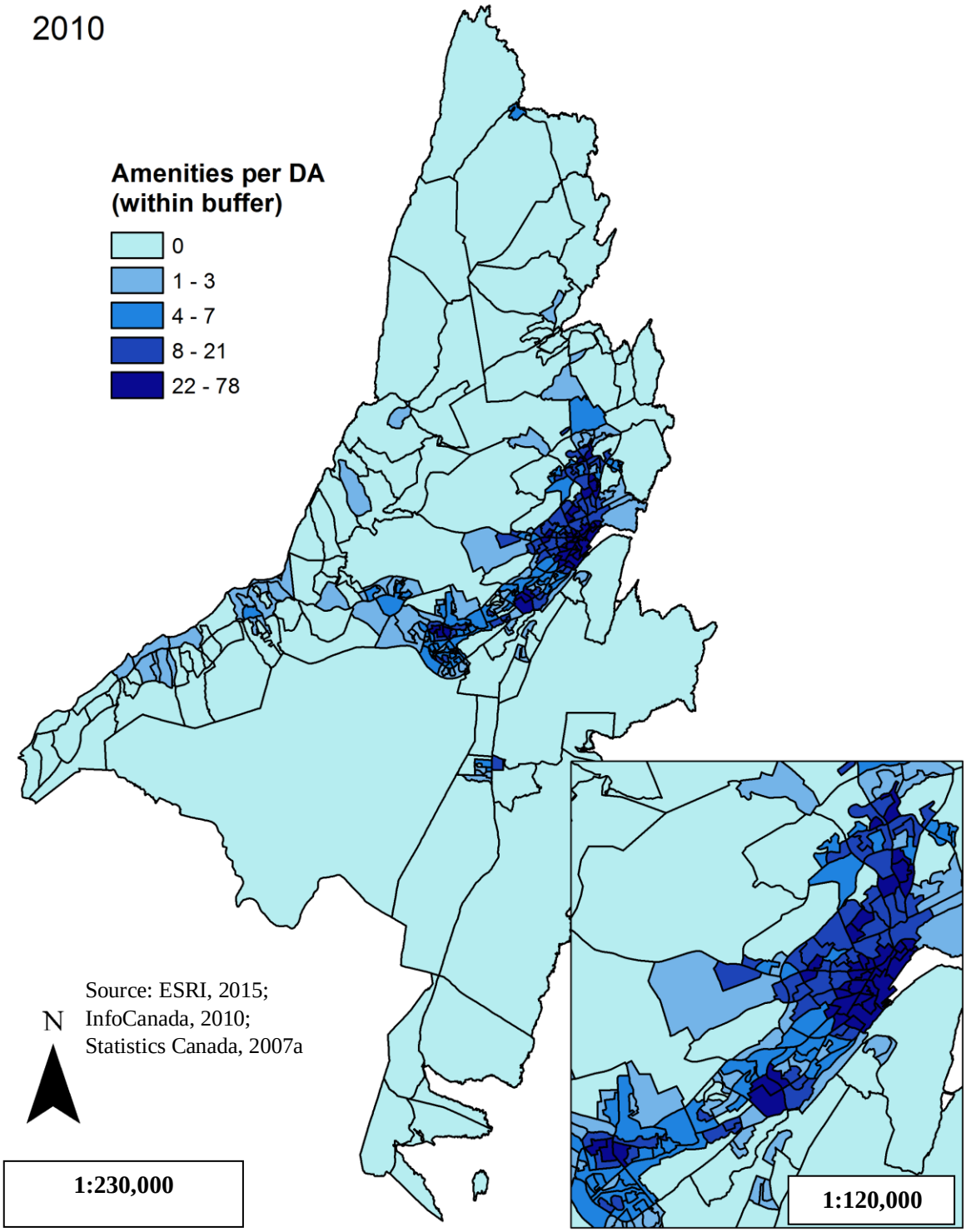


Figure A.7. Amenities per DA under CCII (buffer areas) in the SJCMA, 2010

Figure A.8 shows the number of DAs by number of accessible amenities (500 meters from their centroids). The more apparent pattern is that the majority of dissemination areas have either 0 or more than 10 accessible amenities. DAs with 2, 3, 4 and 5 accessible amenities were in the minority.

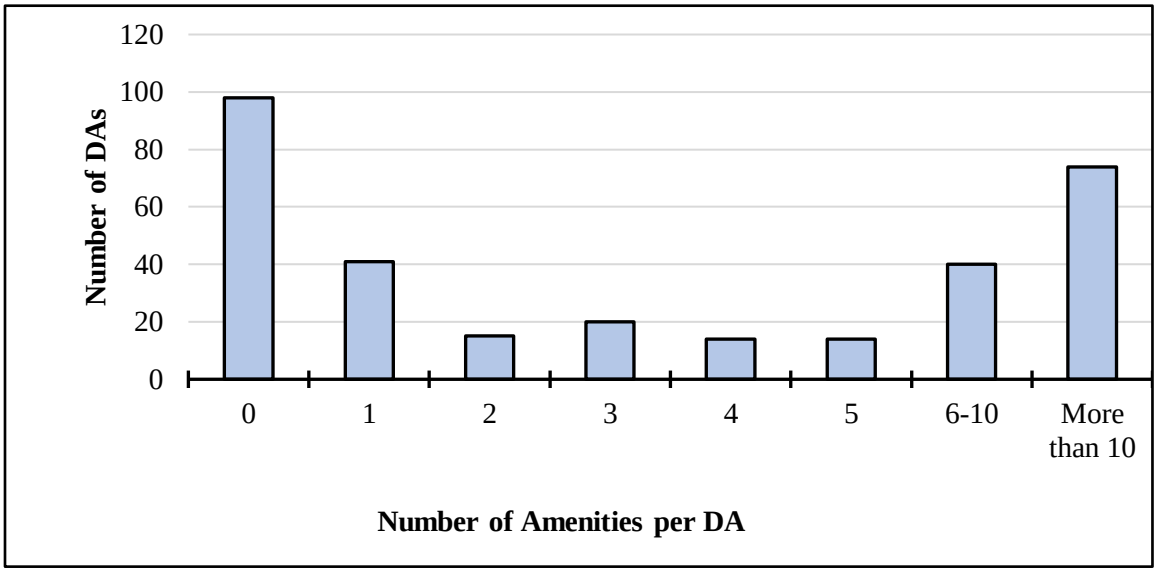


Figure A.8. DAs by average number of amenities in the SJCMA, 2010 (Source: ESRI, 2015, InfoCanada, 2010; Statistics Canada, 2007a)

2.2. Amenities by type (CCII)

A general comparison of the 6 types of amenities selected for this study under the coverage criterion II shows a decline in the number of DAs in the SJCMA with walking access to services and facilities for three types of amenities – food stores, schools, and nursing care – while it shows an increase in the number of DAs with walking access to health, recreational and child care amenities (see Figure A.9). Table A.5 contains descriptive statistics for all amenities and each type of amenity in 2010; Figure A.9 shows a visual comparison by type of amenity. Under CCII, food stores are the most

accessible amenities in the CMA in 2010, followed by recreational amenities, and nursing care services represent the least accessible service. In addition, it logically follows that if amenities are evenly distributed, the more services for a given amenity there are, the higher the number of DAs with at least one amenity. This is the case for schools, and nursing and child care services, but not for the top three amenities, with food stores being the best distributed (123 stores within walking distance and 167 DAs with access to them) given that there were less of them than either health services (288 services within walking distance and 150 DAs) or recreational amenities (185 amenities and 138 DAs).

Table A.5. Descriptive statistics for 6 types of amenities under CCII, SJCMA, 2010 (Source: ESRI, 2015, InfoCanada, 2010; Statistics Canada, 2007a)

	AW 500 m	**DAs WAL1**	**DAs WO**	**MEAN**	**STDEV**	**MED**	**MAX**	**MIN**
All Types	729	220	98	8.05	12.21	3	66	0
Food	123	167	151	1.37	1.88	1	11	0
Health	288	150	168	3.52	6.60	0	36	0
Rec	185	138	180	2.21	5.73	0	47	0
Childcare	58	115	203	0.63	1.09	0	6	0
Schools	54	103	215	0.64	1.13	0	5	0
Nursing	21	49	269	0.22	0.58	0	4	0

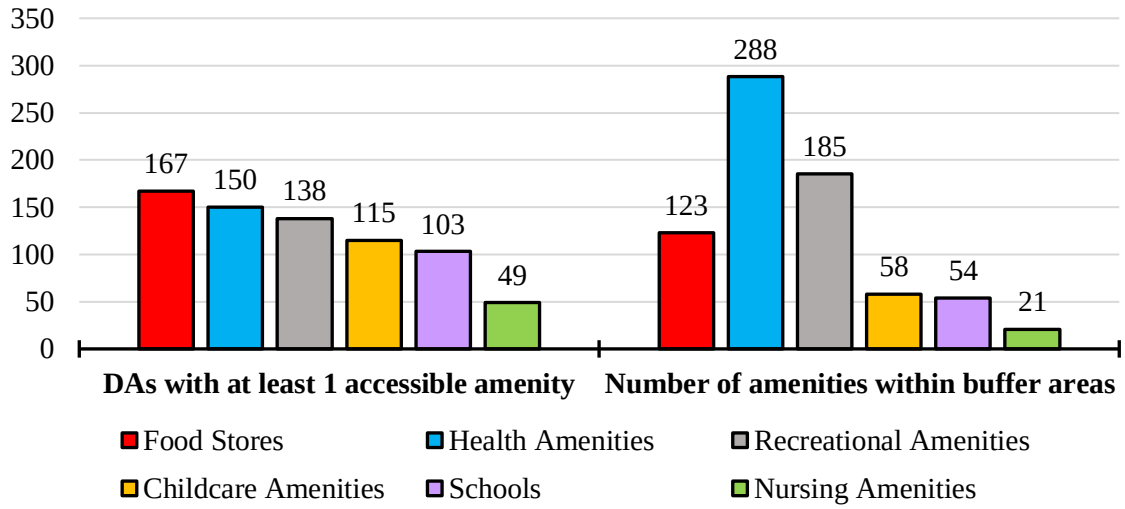


Figure A.9. Number of DAs with access to amenities and number of amenities within buffer areas under CCII, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2007a)

2.3. Amenity mix (CCII)

An amenity mix score was calculated for 318 DAs under the CCII for 2010 (see Figure A.10). The average mix score for the SJCMA in 2010 is 2.27 types of accessible amenities per DA. This shows that on average, 318 DAs across the CMA had access to amenities offering at least two types of services within a 500-metre radius. Finally, there were 21 DAs with walking access to at least one amenity of each type (score of 6). Figure A.11 shows a map of the distribution of mix scores per DA in the SJCMA in 2010. The distribution follows a similar pattern as that of the total number of amenities. There is a concentration of higher mix scores in the eastern urban belt, but there are also pockets of concentration in the north (Pouch Cove and Torbay), the west (Portugal Cove-St. Phillips) and the south (CBS).

Figure A.11 shows the number of DAs and accessible amenities within buffer areas as a dependent variable of the mix scores. A clear observation is that the higher the mix score, the higher the average number of amenities and the lower the number of DAs with that mix score. The mix score with the highest number of DAs is 0, with 97 DAs lacking amenities within 500 m of their centroids. Most of the DAs with accessible amenities have a mix score of 3 and 4 (47). This indicates that, as a whole, 2016 saw more DAs with mixed uses than 2010. In terms of the average number of accessible amenities per DA by mix score, 2016 had higher averages for mix scores of 1, 2, 3 and 4, while 2010 had higher averages for mix scores of 5 and 6.

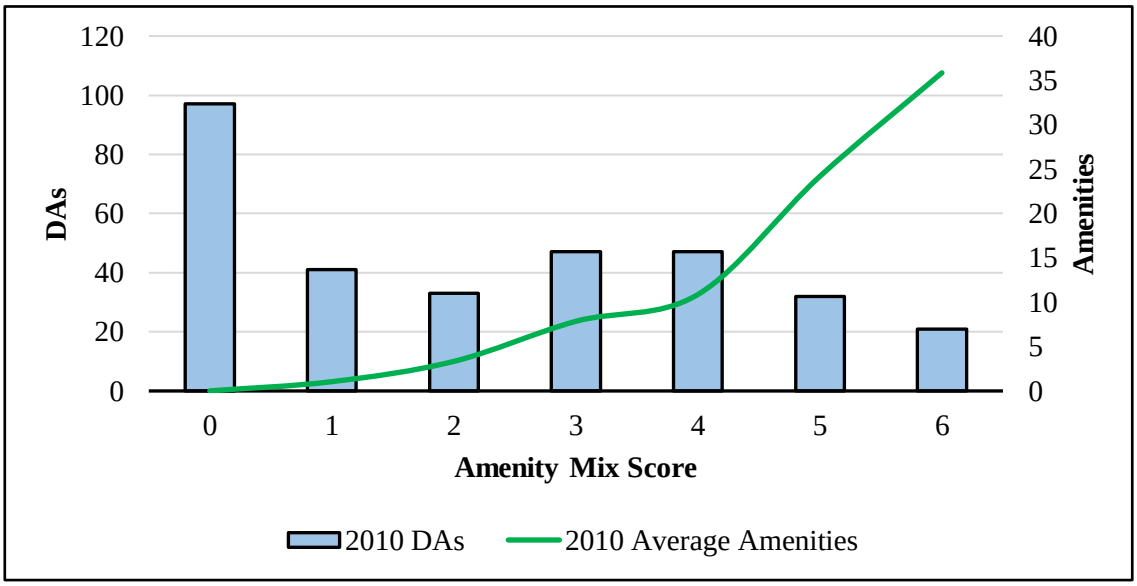


Figure A.10. Number of DAs and average number of amenities by amenity mix score, SJCMA, 2010

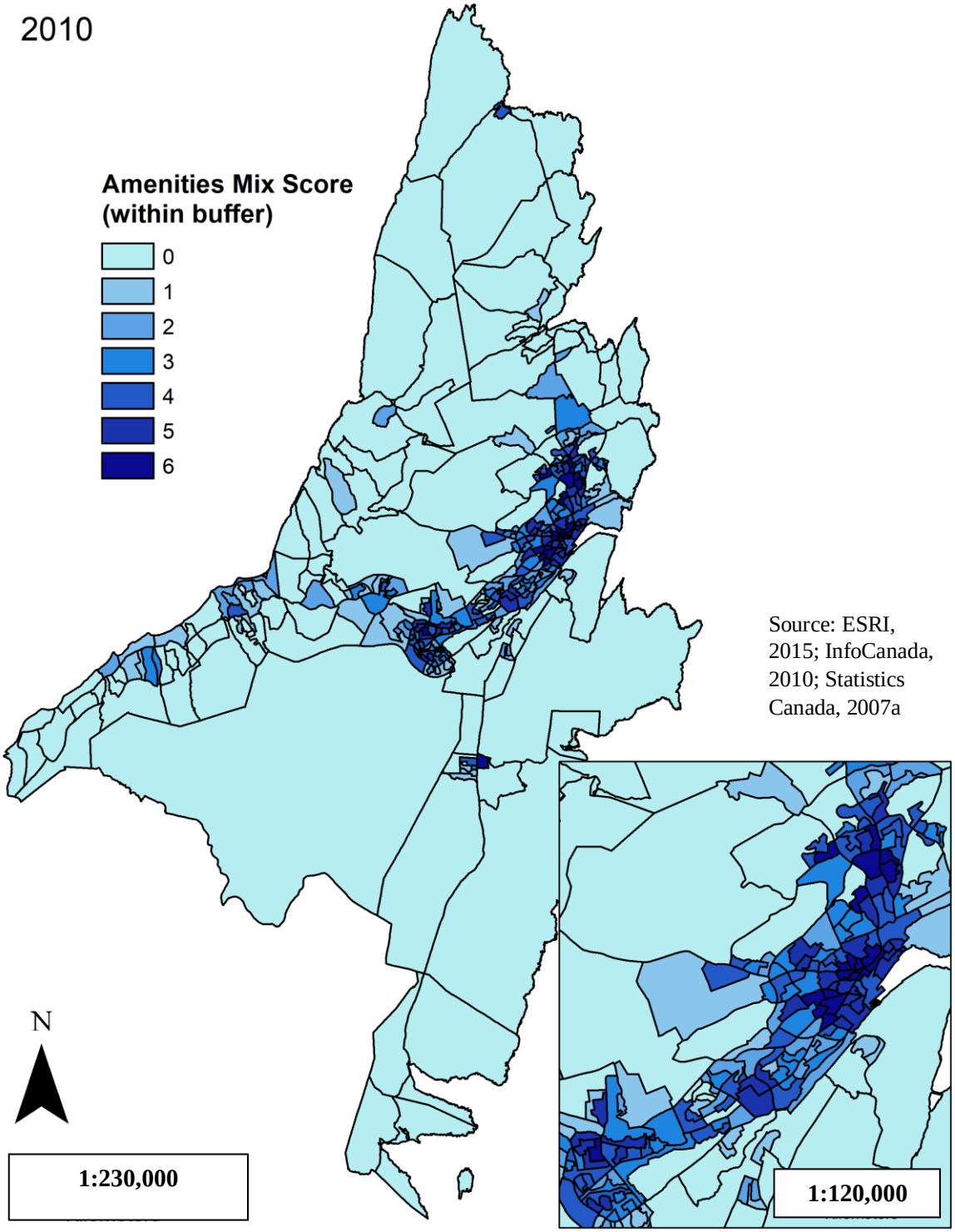


Figure A.11. Distribution of amenity mix scores by DA, SJCMA, 2010

DAs with a mix score of 6

Out of the 318 DAs in 2010, 21 (6.6%) had an amenity mix score of 6, having walking access to at least one amenity of each of the 6 types chosen for this study. These 21 DAs cover 3.24 km^2 in the St. John's Census Metropolitan Area (0.38%). Four of these DAs are located in the northwestern portion of the urban core of the City of St. John's. Eight DAs are located in the center of Central St. John's and in the downtown area – 'old St. John's'. Five DAs are located in western Central St. John's. One DA is located in Goulds and another DA is located in Mount Pearl (see Figure A.12 for a map of the SJCMA with the distribution of the 21 DAs). There are 120 accessible amenities in these DAs, which include 16 food stores, 8 schools, 40 recreational amenities, 7 child care amenities, 6 nursing care amenities, and 43 health amenities. Table A.6 lists the 21 DAs, their distance to the harbour and the amount of amenities within 500m of DAs' centroids. The types of amenities with the highest accessibility are highlighted as well as the 6 DAs with the highest number of accessible amenities[15]. As observed in Table A.6, 6 of the DAs with the highest number of accessible amenities were also the closest to the harbour. In addition, in these 8 DAs, recreational amenities are the most common type of service, whereas health amenities were the most common for another 12 DAs and food stores were the most common facility in 2 DAs, including the one furthest from the harbour.

[15] The numbers listed on the table do not represent the number of amenities within these DAs, which is 120, but the number of amenities that each DA has access to within 500m, which counts each amenity more than once.

Table A.6. DAs with mix score of 6, SJCMA, 2010. (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2007a)

DA_ID	Distance* (km)	Schools	Rec	Food	Nurse	Child	Health	Total
10015190299	0.33	4	47	11	1	3	12	66
10015190298	0.50	5	32	5	2	3	6	47
10015190300	0.68	1	38	10	1	5	11	58
10015190308	0.77	4	30	8	2	3	6	48
10015190230	0.96	5	27	7	2	1	8	44
10015190227	0.98	1	28	8	1	5	16	52
10015190228	1.12	5	28	6	1	5	12	50
10015190229	1.18	4	25	5	1	1	5	36
10015190224	1.72	4	3	5	1	4	32	46
10015190307	1.80	3	3	5	2	2	35	48
10015190255	1.94	1	5	1	2	1	9	17
10015190221	2.18	1	3	4	1	3	9	21
10015190217	2.21	2	2	7	2	1	19	32
10015190218	2.22	2	2	5	2	4	17	32
10015190261	2.52	2	3	2	2	2	17	27
10015190356	2.78	3	3	1	4	1	9	20
10015190262	2.90	4	3	2	2	2	9	20
10015190338	3.41	2	2	4	2	3	3	16
10015190342	3.45	2	1	2	1	1	10	17
10015420626	9.35	4	11	5	1	2	14	37
10015190677	12.86	2	4	6	2	1	5	19

*distance to harbour.

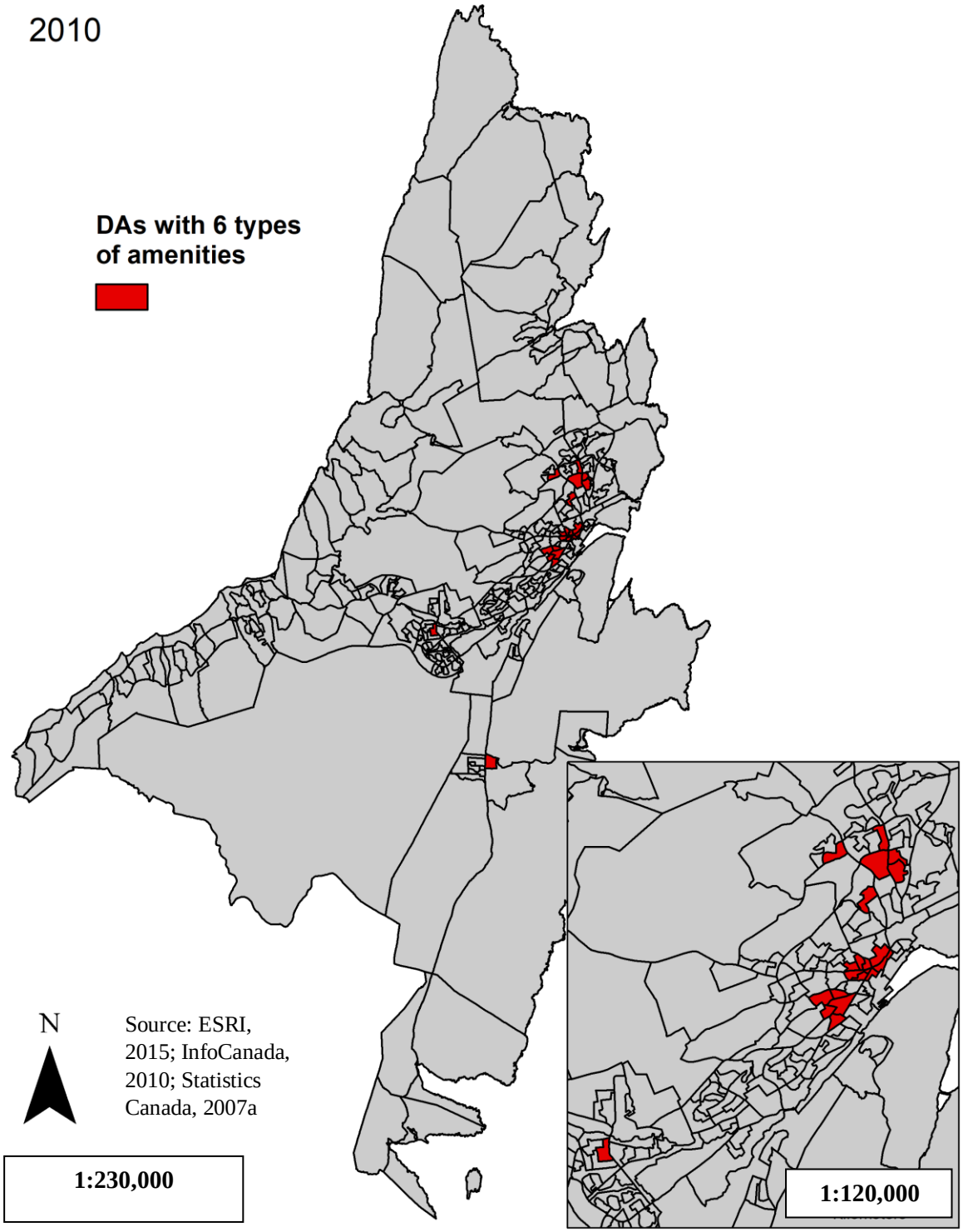


Figure A.12. DAs with access to 6 types of amenities, SJCMA, 2010

3. Coverage criterion III (CCIII) and coverage criterion IV (CCIV)

This section presents a last method for evaluating accessibility in the SJCMA, the coverage criterion III (CCIII), by generating service areas of 500 meters around the dissemination areas' centroids, whose extent, as opposed to buffer areas, is delineated by the road network rather than a straight line. This method is somewhat more reflective of the reality on the ground as compared to CCII because it takes into account the accessibility offered by the street network. However, the network analyst tool in ArcGIS, which generates the service areas, does not take into account the distance between the centroid's coordinates and the closest road or factors in the distance between the road and the amenity's coordinates. Despite these shortcomings, service areas add accuracy to this study. For CCIII, the number of amenities within the service area is counted for the six types of services selected for this study, as it was for the two previous criteria. Towards the end of this section, the three criteria are compared and subsequently averaged to generate a fourth coverage criterion to determine a new count of amenities per DA, which is then used to assess accessibility per capita.

3.1. Comparison of four coverage criteria

Accessibility under CCIII yields lower values than CCI and CCII in terms of DAs with at least one amenity (-57 and -76, respectively), as well as total amenities, resulting in 326 less amenities than CCI and 171 less amenities than CCII. Overall, evaluation of accessibility under CCII yields the highest total of DAs with at least one amenity and CCI yields the highest total of accessible amenities (see Figure A.13).

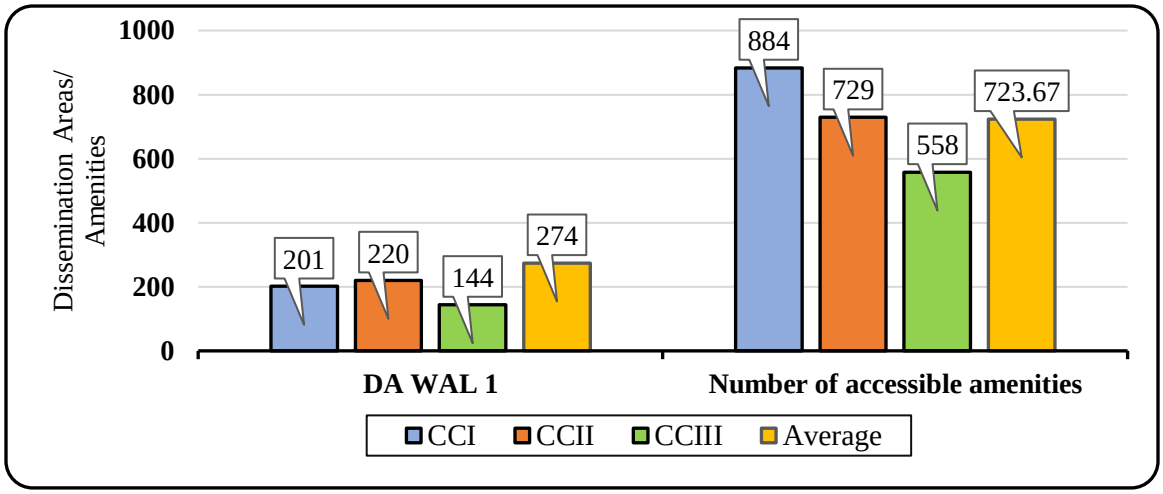


Figure A.13. DAs with at least 1 amenity and number of accessible amenities under four coverage crtiteria

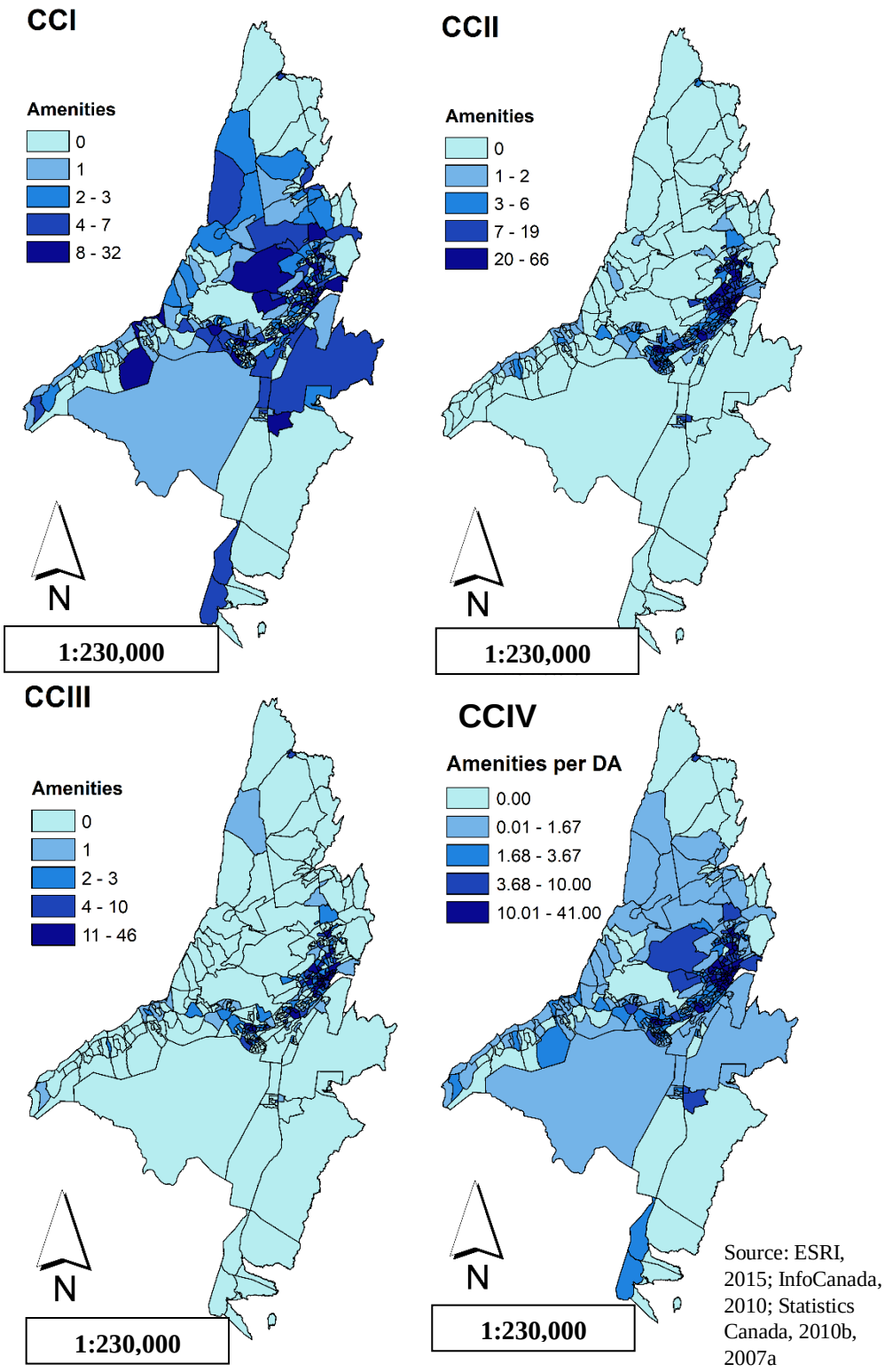
Table A.7 lists other metrics under the three criteria. CCIII has a higher average of accessible amenities in the CMA than CCI but lower than CCII. CCIII also has a higher number of amenities in a single DA (maximum) than CCI but lower than CCII. Overall, CCII shows the highest mean and median values for accessible amenities throughout the CMA. CCIV yields a much higher number of DAs with at least 1 amenity (274) than each of the three other criteria; a total number of amenities close to CCII; about half of the average under CCII; and a maximum number of amenities close to CCIII.

Table A.7. Descriptive statistics for CCI, CCII, CCIII, and CCIV (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

	CCI	CCII	CCIII	CCIV
DA with at least 1 amenity	201	220	144	274
Number of accessible amenities	884	729	558	723.67
Mean	2.78	8.05	3.53	4.79
Standard Deviation	4.69	12.21	8.16	7.34
Median	1	3	0	1.83
Maximum	32	66	46	41
Minimum	0	0	0	0

In regard to spatial accessibility, a comparison of the four coverage criteria shows significant differences. First, as observed in Table A.7, CCIV has the highest number of DAs (274) with at least 1 amenity, while the most uneven distribution is under CCIII (144 DAs). Figure A.14 shows the four distributions in the SJCMA. CCII yields the highest concentration along the urban belt, while CCIII has a similar distribution along the belt, with outlier DAs across the CMA. CCI is highly disperse while CCIV yields a distribution along the core belt that highly resembles that under CCII, but with amenities distributed elsewhere, similar to the distribution under CCI.

Figure A.15 shows an amplified regional core and the resulting distribution of amenities under the four scenarios. Under CCII, Downtown and Central St. John's as well as Mount Pearl show the highest concentrations of amenities, particularly in DAs closest to the harbour. Under the CCIII, there is a clear loss of accessible amenities in the southwestern areas of old St. John's and in Mount Pearl, making the divide between southwest and northeast more pronounced. CCIV shows a distribution in the belt resembling that of CCII, with a high consolidation of amenities in the regional core.



Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b, 2007a

Figure A.14. Geographical distribution of coverage criteria

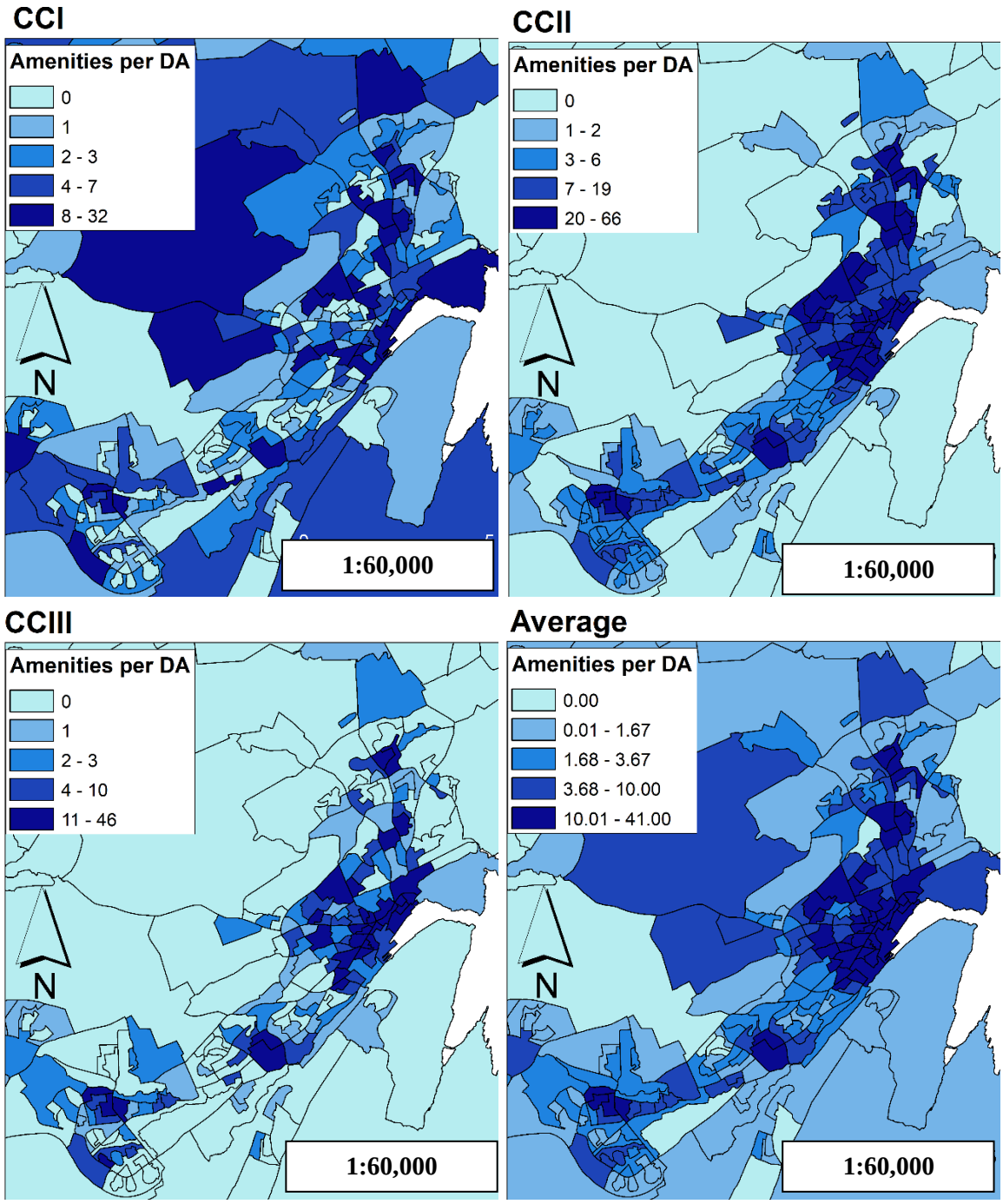


Figure A.15. Geographical distribution of amenities in the SJCMA Core under four coverage criteria, 2010

3.2. Coverage criterion III: Amenities by type

Figure A.16 and Table A.8 shows the dissemination areas with at least one amenity. Among the three measuring criteria, CCIII yields the highest numbers of DAs for every Accessibility for each type of service under the four scenarios is examined in this section type of amenity, with food stores (167 DAs) being the type of service found most frequently in the SJCMA. CCIII shows the second highest number of DAs with at least one food store (87), whereas CCI yields the second highest number of DAs with at least one health service/facility (94). At the lowest end of the spectrum, nursing amenities is the type of service found the least frequently in the SJCMA under all four criteria (29 DAs, 49 DAs, and 22 DAs, respectively). In addition, the amenity with the second lowest distribution in the CMA is schools under CCI (43 DAs) and CCII (103 DAs) and childcare services under CCIII (50). CCIV yields the highest number of DAs with at least one type of amenity. This is because it includes DAs with averages of 0.33 and 0.67.

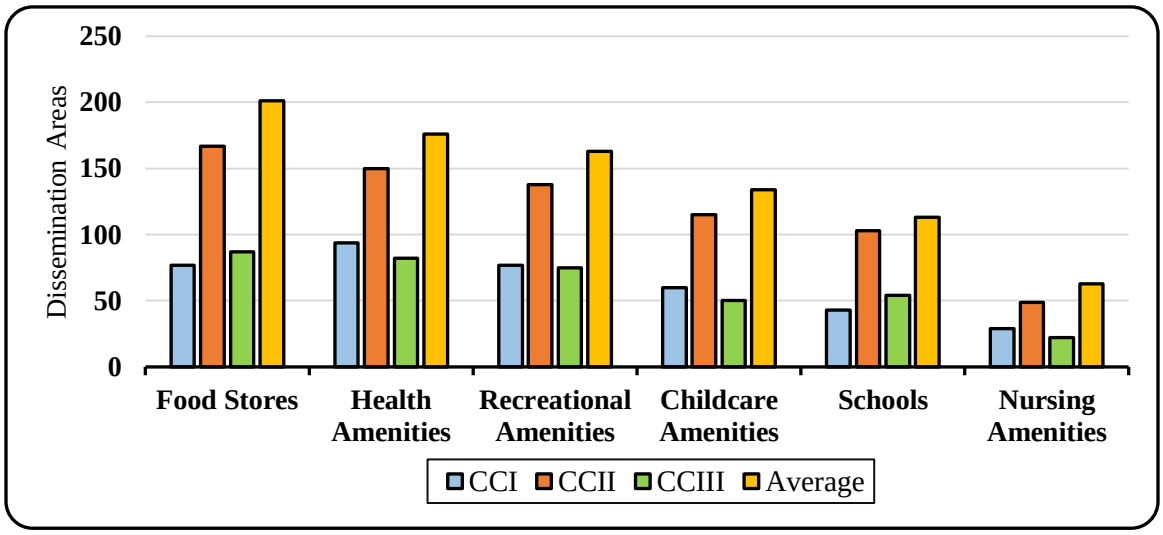


Figure A.16. Dissemination areas with at least one amenity by type of amenity under four coverage criteria (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

Table A. 8. Descriptive statistics by type of amenity by criteria, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

	Amenities	**DAs WAL 1**	**DAs WO**	**MEAN**	**STDEV**	**MED**	**MAX**	**MIN**
Food								
CCI	155	77	241	0.49	0.81	0	5	0
CCII	123	167	151	1.37	1.88	1	11	0
CCIII	92	87	231	0.57	1.22	0	7	0
CCIV	123.33	201	117	0.81	1.11	0.33	6.33	0
Schools								
CCI	63	43	275	0.20	0.56	0	4	0
CCII	54	103	215	0.64	1.13	0	5	0
CCIII	39	54	264	0.25	0.64	0	4	0
CCIV	52	113	205	0.36	0.65	0	3	0
Rec								
CCI	224	77	241	0.59	1.93	0	23	0
CCII	185	138	180	2.21	5.73	0	47	0
CCIII	138	75	243	1.06	3.71	0	29	0
CCIV	182.33	163	155	1.32	3.39	0.33	26.67	0
Health								
CCI	336	94	224	1.06	2.51	0	19	0
CCII	288	150	168	3.52	6.60	0	36	0

CCIII	234	82	236	1.36	4.12	0	33	0
CCIV	286	176	142	1.98	3.87	0.33	29.33	0
Nursing								
CCI	34	29	289	0.11	0.37	0	3	0
CCII	21	49	269	0.22	0.58	0	4	0
CCIII	15	22	296	0.08	0.29	0	2	0
CCIV	23.33	63	255	0.13	0.33	0	2.67	0
Child								
CCI	72	60	258	0.23	0.51	0	3	0
CCII	58	115	203	0.63	1.09	0	6	0
CCIII	40	50	268	0.21	0.59	0	5	0
CCIV	56.67	134	184	0.36	0.59	0	4	0

In terms of total number of amenities, health amenities offer the highest number of accessible services across the SJCMA (336, 288 and 234 amenities, respectively), while recreational amenities is the second highest for all three criteria (224, 185, and 138, respectively). Nursing amenities is the amenity with the lowest amount of accessible services offered in all three criteria (34, 21, and 15, respectively).

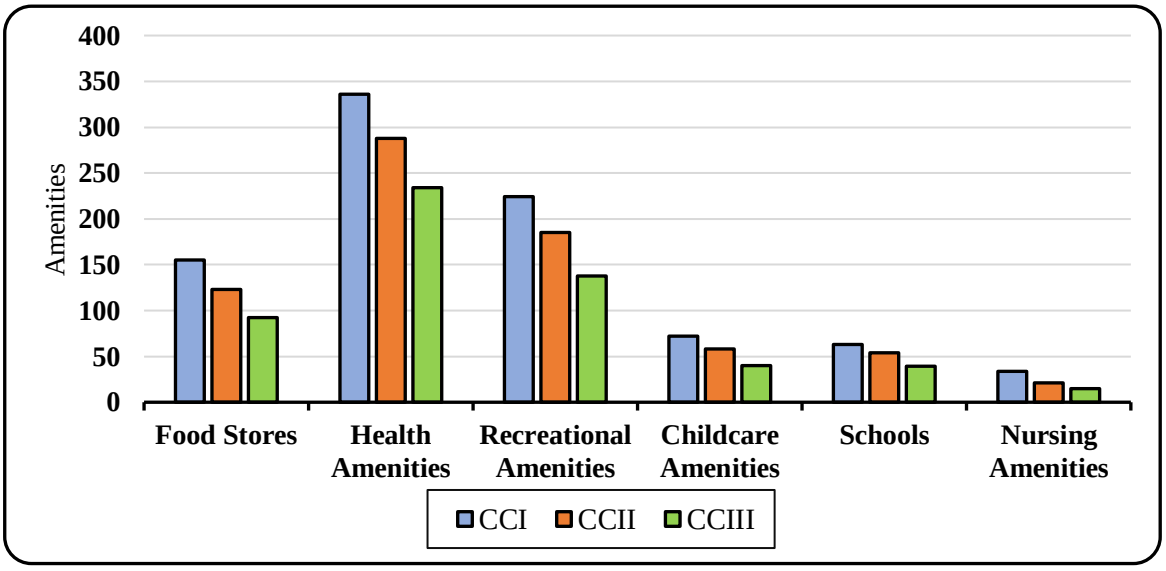


Figure A.17. Total amenities by type under three measuring criteria, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

Spatial accessibility for 6 types of amenities under four scenarios

In terms of geographical distribution, Figures A.18-23 show the distribution of schools, food stores, recreational and health amenities, child care and nursing care services across the SJCMA under the four scenarios. The four scenarios yield very similar spatial patterns for all types of amenities, with absolute higher concentration of amenities in the core belt under CCII and CCIV, and relatively higher concentration of amenities in the urban core under CCIII as compared to CCI, and a more even distribution across space under CCI. Specifically, the distribution of schools under CCII and CCIII show a loss of DAs, with at least one school outside of the core. The distribution of schools under CCIV resembles that of CCI at the CMA scale, but shows a higher concentration in the core. Figure 6.36 shows the distribution under CCIV, with the urban belt amplified.

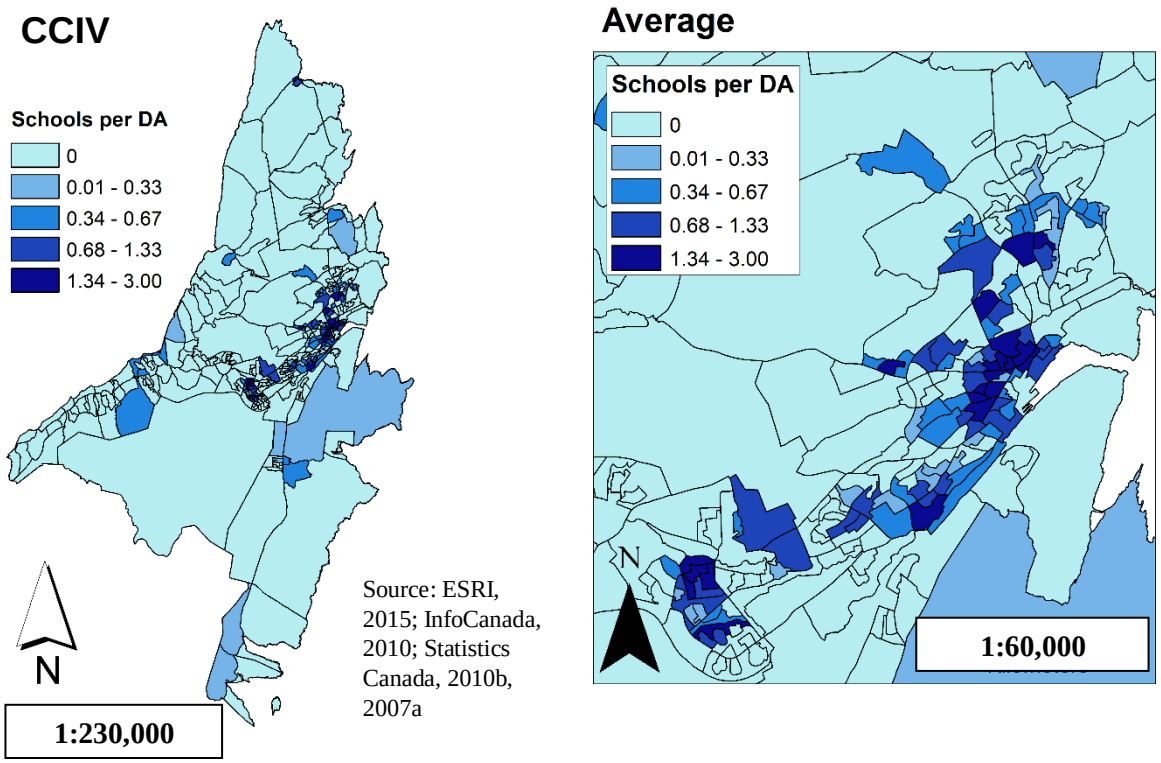


Figure A.18. Distribution of schools under CCIV, 2010, SJCMA

For accessibility to food stores (see Figures 5.20), my analysis reveals that there is a more equal distribution under CCI and the average, but under the two other criteria, the concentration of accessible food stores in the urban belt is unequivocal, with no DAs elsewhere showing any accessibility to stores. In addition, the DAs with access to food stores under CCI and CCIV are exclusively located north and west of the urban belt.

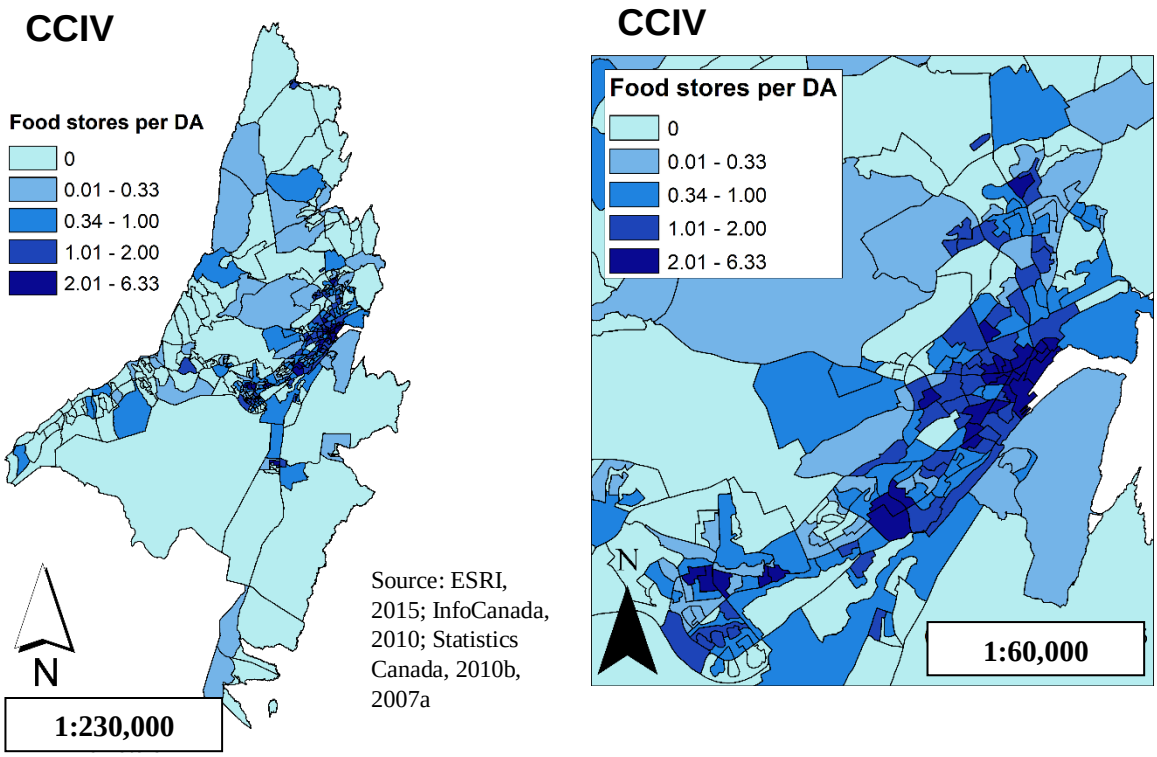
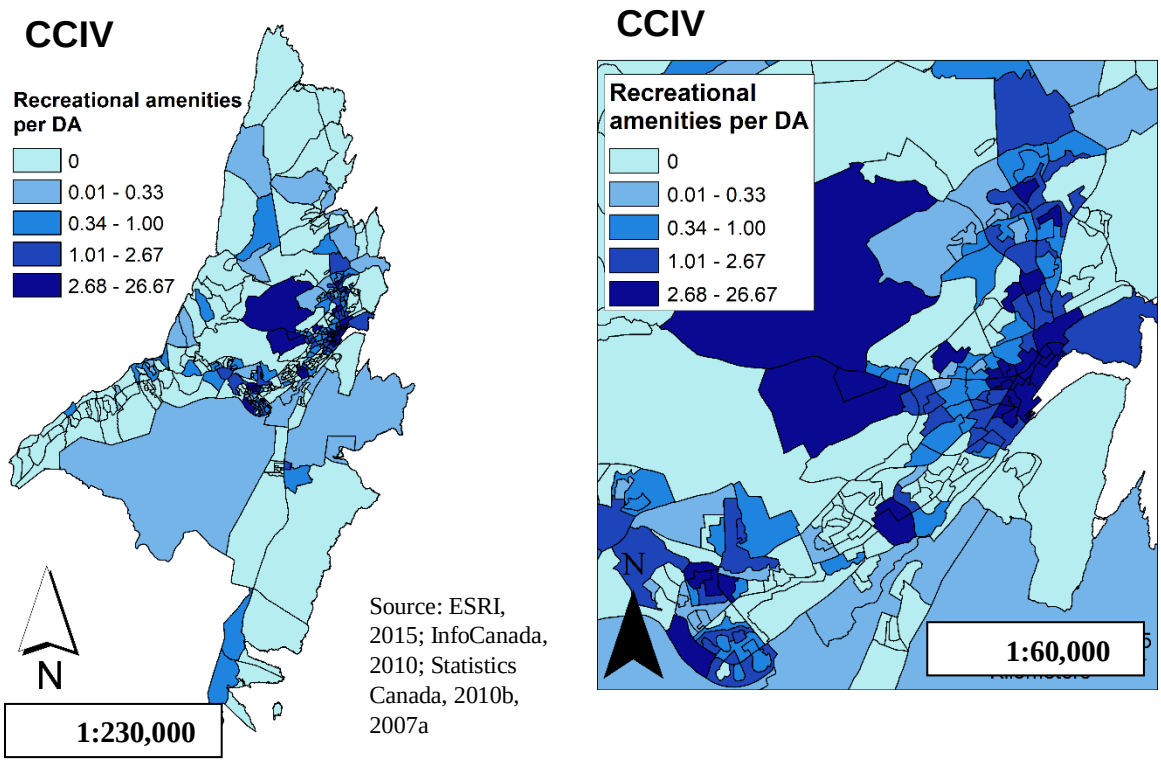


Figure A.19. Distribution of food stores under CCIV, 2010, SJCMA

For recreational amenities (see Figures A.20), there is a similar pattern, but under CCI and CCIV, DAs with access to recreational facilities are all around the CMA, both north and south of the belt.



Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b, 2007a

Figure A.20. Distribution of recreational amenities under CCIV, 2010, SJCMA

In the case of health amenities (see Figure A.21), the concentration of accessible amenities along the belt is also unequivocal under the four scenarios, but CCI and CCIV show some DAs in the eastern side of the CMA, right outside of the urban belt.

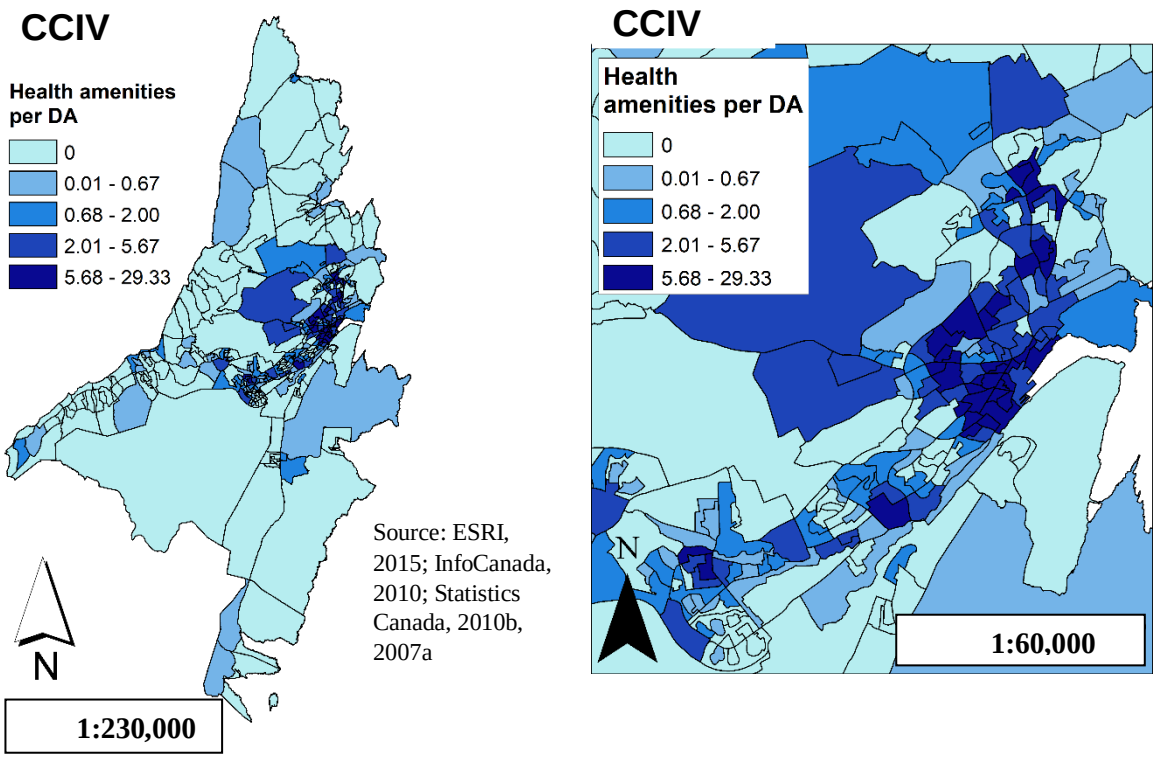


Figure A.21. Distribution of health amenities under CCIV, 2010, SJCMA

For nursing care amenities (see Figure A.22), there is a similar distributional pattern, but their low amount means that there is no high concentration of accessibility anywhere in the CMA; and within old St. John's, the few accessible nursing care facilities are concentrated in the central and northeastern side of the old city.

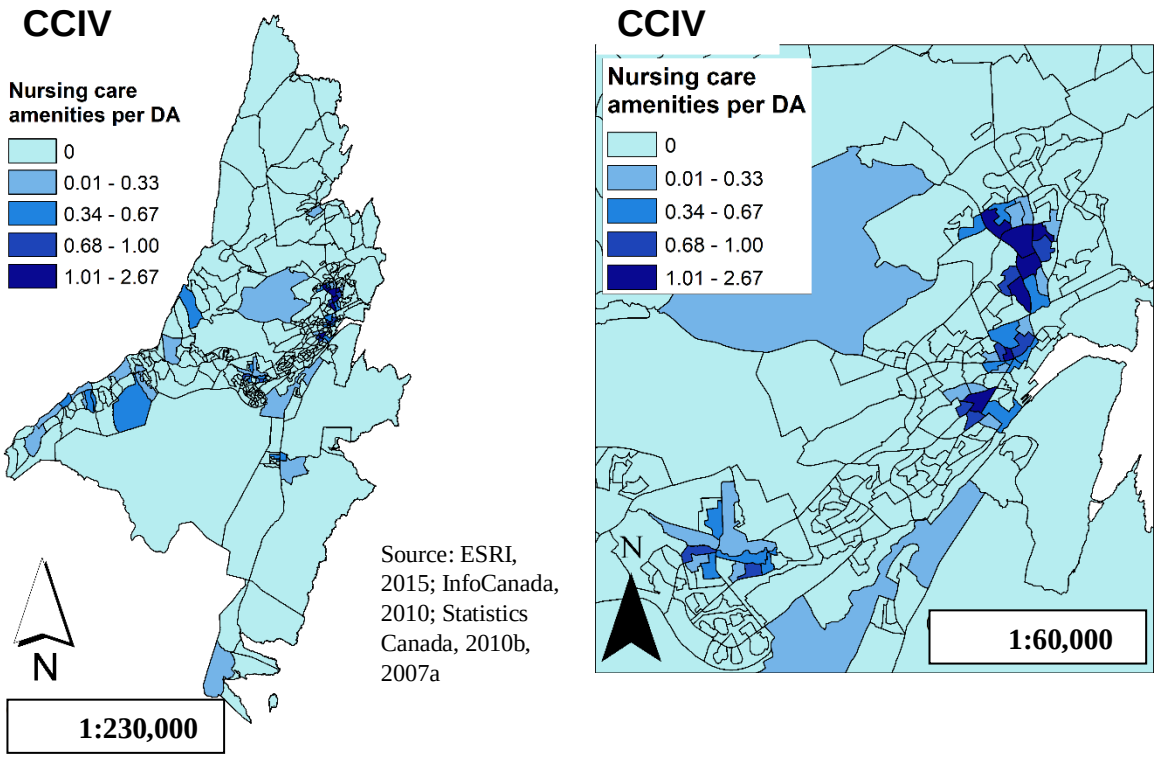


Figure A.22. Distribution of nursing care amenities under CCIV, 2010, SJCMA

In the case of child care services (see Figure A.23), most amenities are concentrated in the eastern portion of the CMA. The highest concentrations in the belt occur under CCIII and CCIV, while under CCII, there is dispersion of accessibility across the belt and under CCI there is little concentration and better distribution in the periphery.

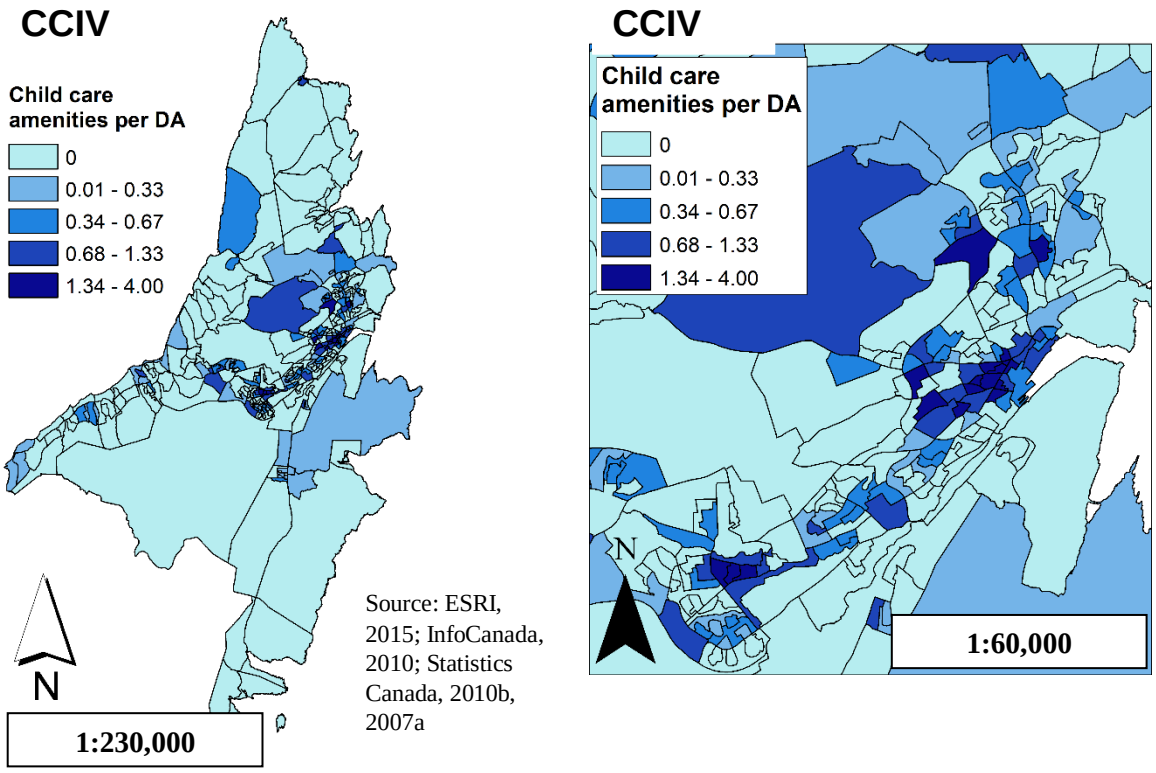


Figure A.23. Distribution of child care amenities under the average scenario, SJCMA, 2010

The maps above show that the distribution of amenities across the St. John's CMA is quite unequal. The urban DAs have the majority of services and facilities

3.3. Amenity mix four coverage criteria

A comparison of amenity mix scores under the three criteria (see Figure A.24) shows a clear contrast between scores under the three scenarios. Whereas CCII yields the highest number of DAs with scores of 3, 4, 5, and 6, CCI yields the highest number of DAs with scores of 1 and 2 and CCIII yields the highest number of DAs without any amenities (a score of 0). This signifies that the highest mixing occurs when accessibility is analyzed

with 500m buffer areas rather than 500m service areas or a simple count of amenities within the borders of the DA. It is also worth noting that, in terms of average amenities by mix score, CCIII yields the highest average in DAs with DAs having access to 3, 4 and 6 types of amenities (8.52, 11.65, and 36.5 amenities on average per DA, respectively). These results show that even if a measuring criterion yields more mixing in terms of DA count, the number of amenities on average per DA might not be as high. Regardless of the differences, the three scenarios of analysis clearly demonstrate that the higher the amenity mix score, the higher the average number of amenities per DA.

Figure A.25 shows the geographic distribution of amenity mix scores across the SJCMA under the four scenarios. CCI is, again, the scenario with the most diffusion and even distribution of mix scores, whereas CCII and CCIII concentrate the higher mix scores along the urban belt and CCIV is a middle point between CCI and CCII.

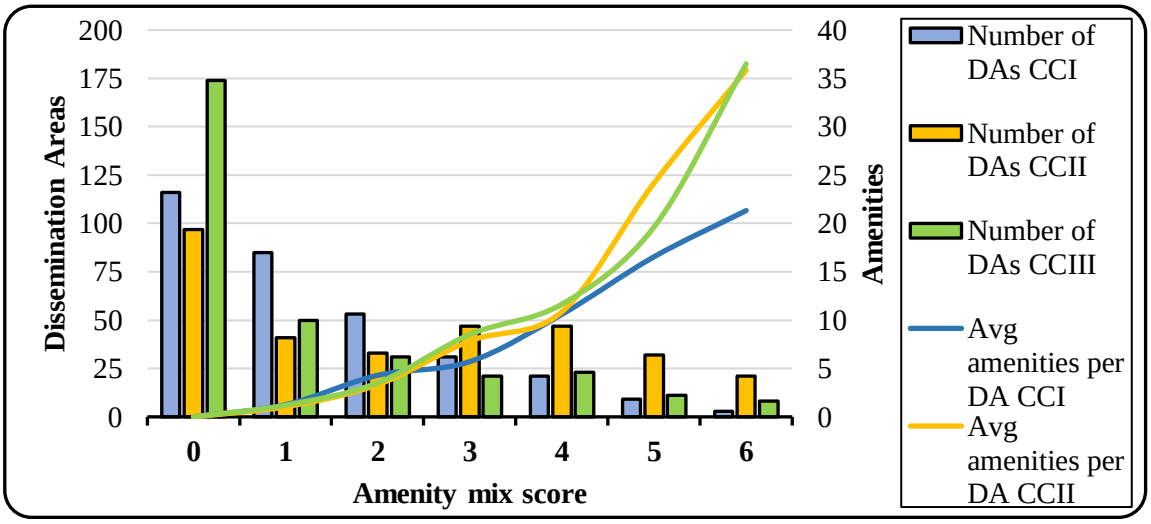


Figure A.24. DAs and average amenities by amenity mix score under the three measuring criteria (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

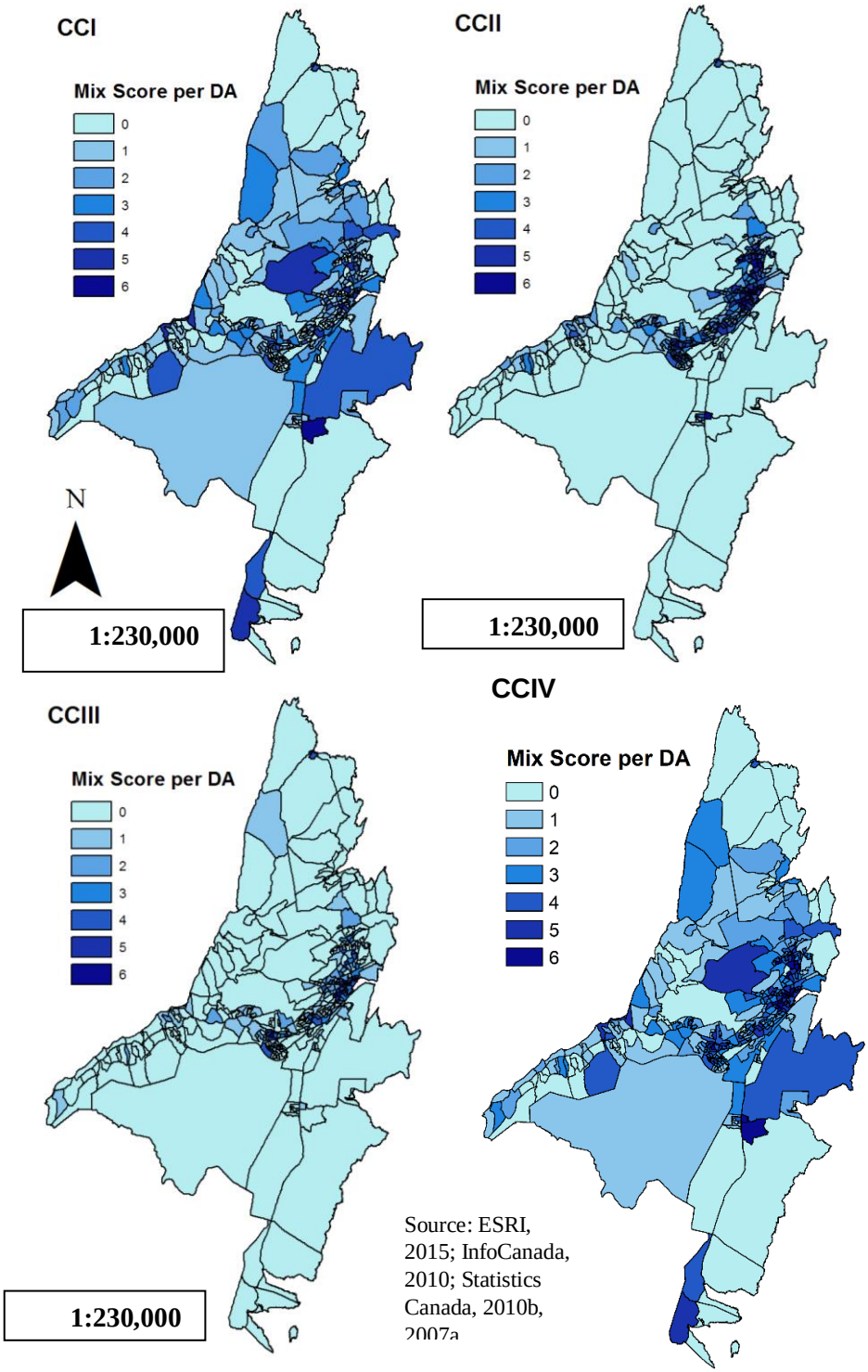


Figure A.25. Geographical distribution of amenity mix scores in the SJCMA in 2010 under four measuring criteria

DAs with 6 types of amenities (CCIII)

Under coverage criteria III, an analysis on DAs with 6 types of amenities (mix score of 6) yields 8 DAs, most of which are located in Downtown St. John's and western Central St. John's (see Figure A.26). Table A.9 lists the DAs with scores of 6 in the SJCMA under CCIII. With the exception of the last two DAs, all dissemination areas have a similar number of amenities, and the most frequently offered is recreational amenities for 5 out of 8 DAs. The DA furthest from the St. John's harbour has 11 health amenities, the highest among all of the 8 DAs.

Table A.9. DAs with access to six types of amenities, SJCMA, 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

DA_ID	Dist_Harbour	Schools	Food	Rec	Health	Nursing	Child	Total
10015190307	0.18	2	3	2	32	2	1	42
10015190299	0.33	2	4	29	6	1	1	43
10015190300	0.68	1	7	25	9	1	3	46
10015190308	0.77	3	7	26	5	1	1	43
10015190230	0.96	2	5	25	4	1	1	38
10015190228	1.12	4	3	25	7	1	3	43
10015190218	2.22	2	1	1	1	1	3	9
10015420626	9.35	1	5	9	11	1	1	28

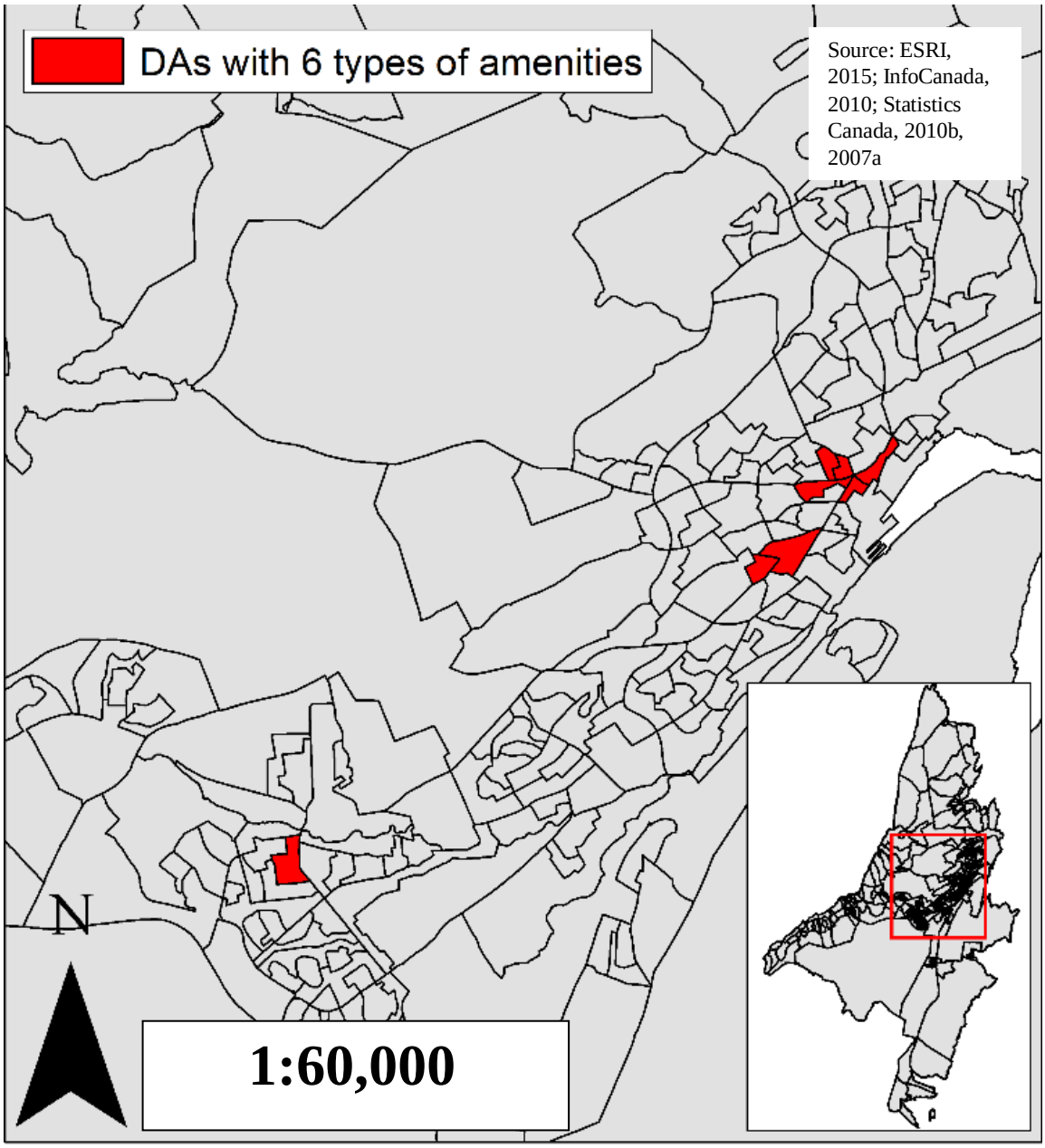


Figure A.26. DAs with 6 types of amenities under CCIII in the SJCMA, 2010

4. Euclidean minimum distance

In 2010, the average minimum Euclidean distance for all amenities (six types) across the CMA was 547.17 meters as measured from DA centroids to the closest amenity, while the median minimum distance was 300.08 meters. Descriptive statistics for Euclidean minimum distances for each type of amenity is summarized in Table A.10 and presented in Figure A.27. The amenity with the shortest average distance in 2010 was food stores, with an average of 817.07 meters from the DA centroid and a median minimum distance of 475.14 m. This is followed by health amenities with a minimum average distance of 978.99 m. and a median minimum distance of 536.62 meters. On the other end of the spectrum, the amenity with the longest average minimum distance was nursing care amenities, with an average distance of 1687.04 meters. The most accessible amenity was a food store at 11.72 meters from the closest DA centroid, whereas the furthest distance to an amenity was to a child care service, at 19,393.20 meters, almost four times the established walking distance standard.

These results demonstrate that the average minimum distance for all 6 types of amenities in the SJCMA in 2010 is higher than the established maximum walking distance of 500 m to make an amenity accessible. None of the average minimum distances fall within the 500m limit. The only amenity whose median falls within the 500m limit is food stores.

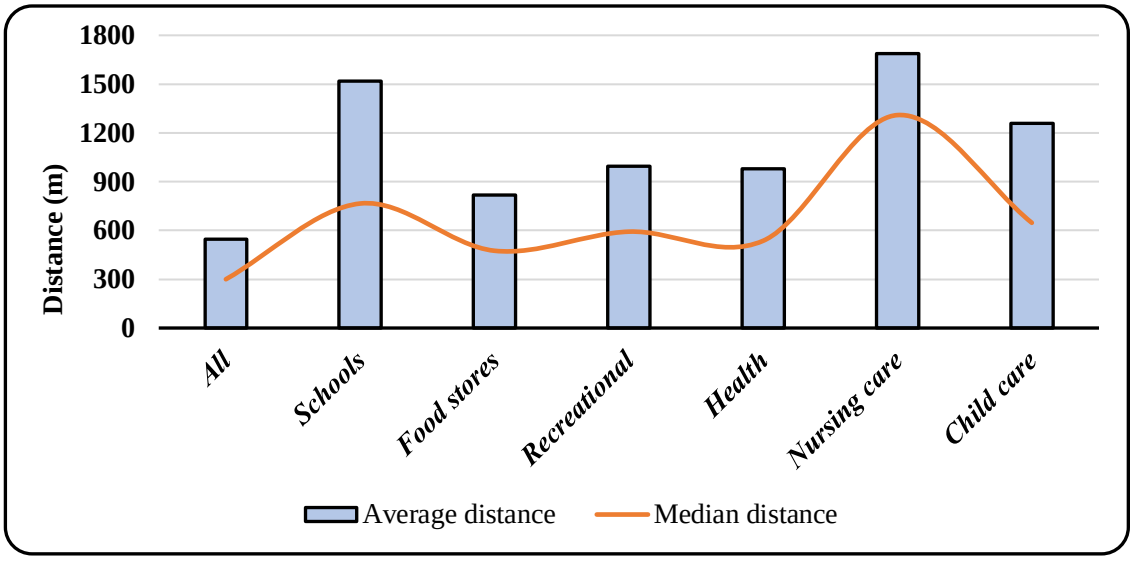


Figure A.27. Average and median distance by type of amenity, SJCMA, 2010

Table A.10. Descriptive statistics for Euclidean minimum distances to all and each type of amenity in the SJCMA in 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

	Average distance (m)	Median distance (m)	STDEV	MAX	MIN
All	547.17	300.08	807.64	7100.49	11.72
Schools	1519.04	765.72	1893.52	11915.02	45.40
Food stores	817.07	475.14	973.10	7797.51	11.72
Recreational	995.45	592.65	1303.23	10208.14	22.13
Health	978.99	536.62	1173.29	7573.24	23.56
Nursing care	1687.04	1309.57	1610.10	12681.89	76.85
Child care	1259.94	647.21	2168.70	19393.20	59.58

5. Network minimum distance

In 2010, the average network minimum distance – as measured along the street network – for all six types of amenity across the CMA was 843.94 meters as measured from DA centroids to the closest amenity on the road network, while the median minimum distance was 530.21 meters. Descriptive statistics for network minimum distances for amenity by

type is summarized in Table A.11 and presented in Figure A.28. The amenity with the shortest average minimum distance in 2010 was food stores, at 1274.93 meters and a median minimum distance of 766.85 meters. This is followed by health amenities with a minimum average distance of 1484.10 meters and a median minimum distance of 859.35 meters. On the other end of the spectrum, the amenity with the longest average minimum distance was nursing care amenities, at 2446.45 meters. The most accessible amenity was a recreational facility at a distance of 2.54 meters from the closest DA centroid, whereas the furthest distance to an amenity was to a child care service, at 21,418.98 meters, over four times the established walking distance.

These results demonstrate that the average and median network minimum distance for all 6 types of amenities in the SJCMA in 2010 is 343.94 meters higher than the established maximum walking distance of 500 m to make an amenity accessible. None of the average or median network minimum distances fall within the 500m limit.

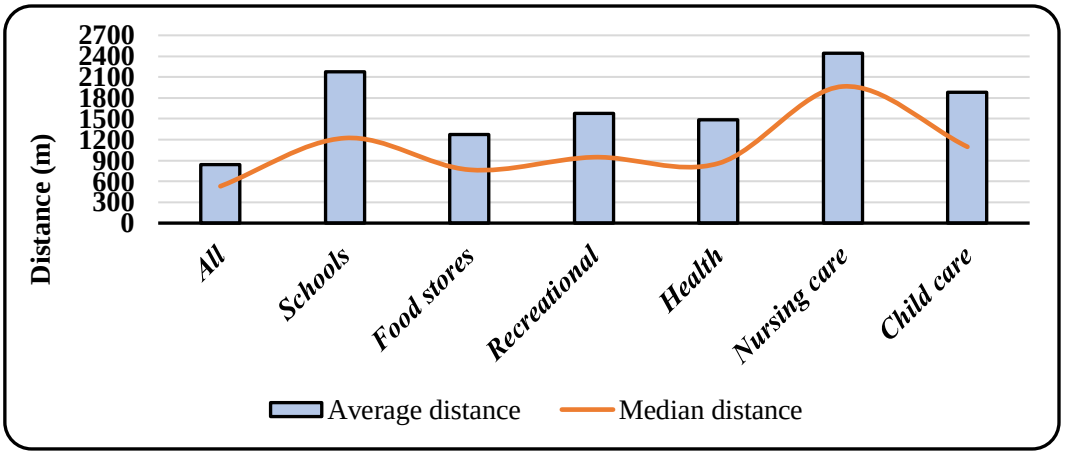


Figure A.28. Average and median network minimum distance to amenities by type in the SJCMA in 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

Table A.11. Descriptive statistics for network minimum distances to all and each type of amenity in the SJCMA in 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

	Average distance (m)	Median distance (m)	STDEV	MAX	MIN
All	843.94	530.21	1,165.51	10,719.03	2.49
Schools	2,172.69	1,222.61	2,385.08	14,784.74	19.08
Food stores	1,274.93	766.85	1,381.08	11,040.41	11.58
Recreational	1,576.81	947.47	2,102.90	17,112.72	2.54
Health	1,484.10	859.35	1,628.43	10,887.38	14.44
dNursing care	2,446.45	1,964.87	2,303.17	17,210.50	75.58
Child care	1,878.10	1,096.99	2,636.45	21,418.98	33.80

6. Euclidean vs network minimum distance

When comparing the two minimum distance measurements, Euclidean and network, distances calculated with network analysis are between 43% and 58% higher than Euclidean distances (see Table A.12 and Figure A.29 for a comparison of the two measurements). The amenity with the highest difference in distance is recreational amenities (+58%) and the one with the lowest difference is schools (+43%).

Table A.12. Comparison of two distance measures by amenity type in the SJCMA in 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

	Euclidean (m)	Network (m)	Change (%)
All amenities	547.17	843.94	+54
Schools	1519.04	2172.69	+43
Food	817.07	1274.93	+56
Recreation	995.45	1576.81	+58
Health	978.99	1484.10	+52
Nursing	1687.04	2446.45	+45
Child care	1259.94	1878.10	+49

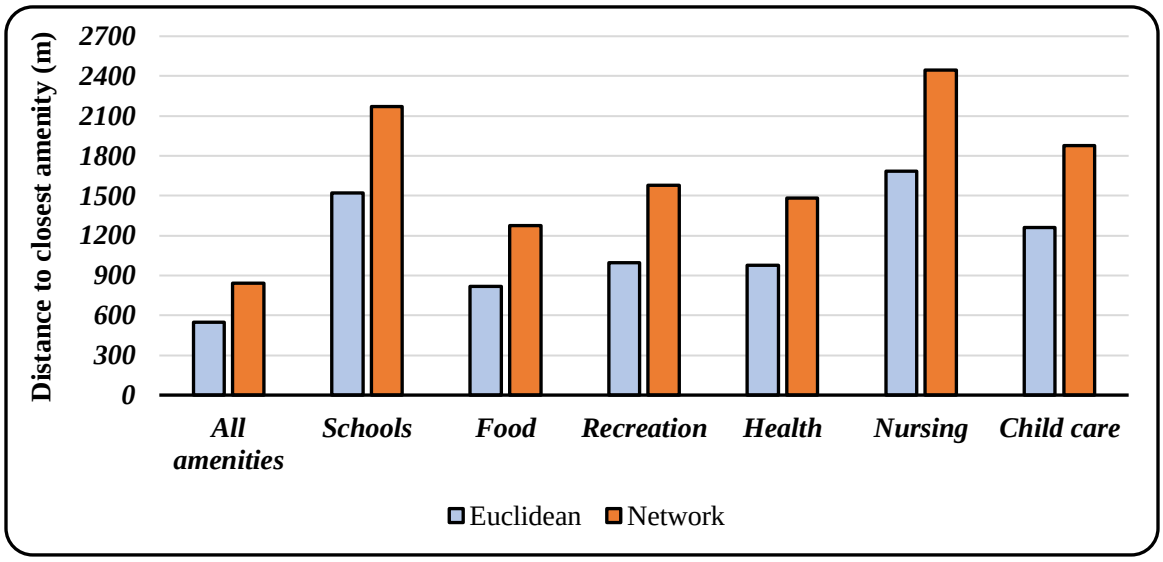


Figure A.29. Comparison of distance measures by amenity type in the SJCMA in 2010 (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2010b; 2007a)

This difference can be explained by the Pythagoream theorem when, in a right triangle, the hypotenuse is greater than any one of the other sides of the triangle, but less than their sum. Although the street network in St. John's is hardly on a rectangular grid, the distance on the street network is, on average, always greater than as the crow flies. For a visual explanation of this occurrence, Figure A.30 shows a portion of Central St. John's with DA centroids and a few amenities nearby. The green line shows the network distance from a DA centroid (blue square) to the closest amenity (red circle). It measures at approximately 464 meters. The orange line represents the Euclidean minimum distance from the centroid to the closest amenity at approximately 354 meters. The orange line can be thought of as the approximation of the hypotenuses of a series of right triangles. In certain instances, however, the network distance can be shorter than the Euclidean distance, in part, due to the fact that the latter adds in the distance from the centroid to the road and from the amenity to the road, while the network analysis only generates a line

along the road. This can be observed in the case of a second blue centroid, with a black line depicting the Euclidean distance measure and a purple line depicting the network distance. The former measures 81 meters while the latter measures 69 meters.

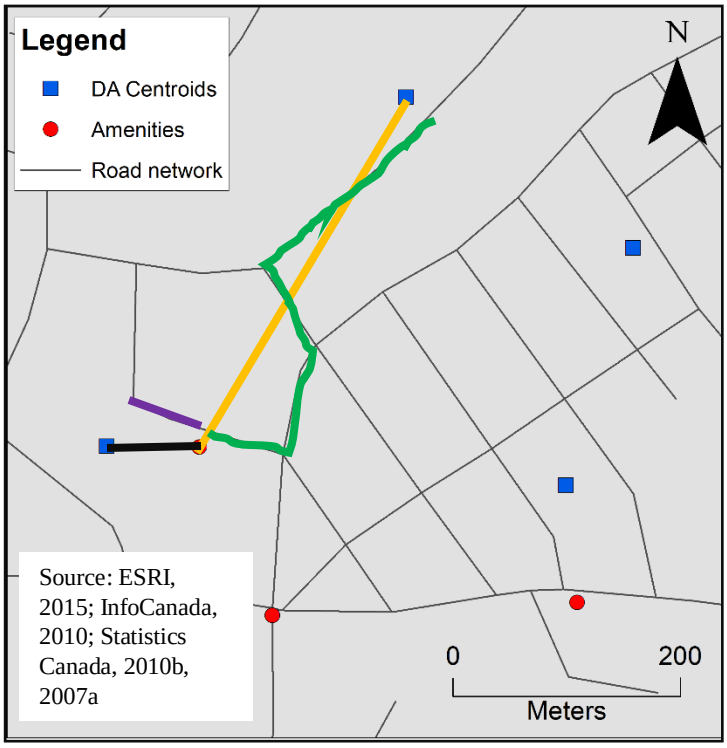


Figure A.30. Visualization of difference between Euclidean and network distance measures on ArcGIS for measuring minimum distance

7. Accessibility to 6 types of amenities by demographic group

In Figure A.31, ranges of population **ages 0 to 14** are plotted against average amenities per DA for each type of amenity researched in this study. It can be discerned from the graph that, in DAs with lower numbers of children and youth, health and recreational amenities as well as schools and food stores are in more abundance than in DAs with higher numbers of children and youth. The highest average number of recreational amenities (3.26 facilities per DA) are found in DAs with 0 to 49 children and youth. In this range, health amenities are also highly abundant, at 5 per DA, while accessible food stores average 1.49 establishments. Schools and child care services are also at their highest, with 0.71 and 0.72 amenities per DA, respectively. As the population aged 0 to 14 increases, every type of amenity declines, with the exception of recreational, health and childcare amenities, which show higher numbers in DAs with more than 300 children and youth.

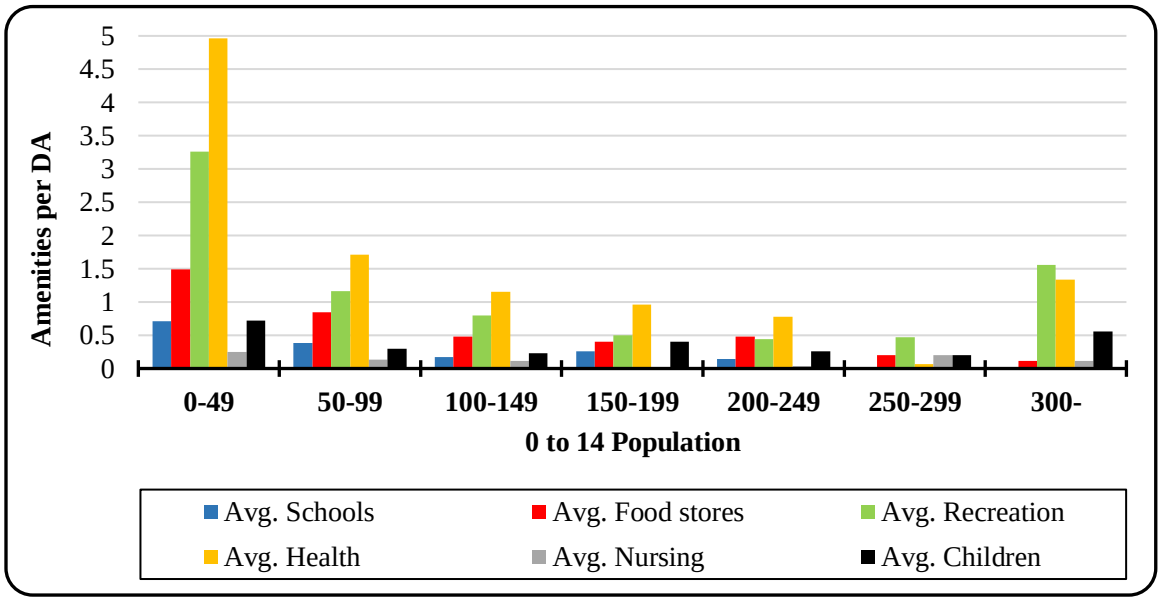


Figure A.31. Amenities per DA (by type) for different concentrations of 0- to 14-year-olds (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

In Figure A.32, ranges of population of seniors are plotted against average amenities per DA for 6 types of amenities. It can be discerned from the graph that, in DAs with 150 to 199 seniors, residents have the highest average number of health (3.63) and recreational (2.11) amenities, as well as food stores (1.59) and childcare amenities (0.48). Higher concentration of seniors enjoy lower number of food stores and health amenities. The highest number of nursing care facilities are found in DAs with the highest concentration of senior residents, indicating a spatial match between amenity and population. The highest concentration of schools is found in DAs with 300 or more seniors, at 0.17 amenities per DA.

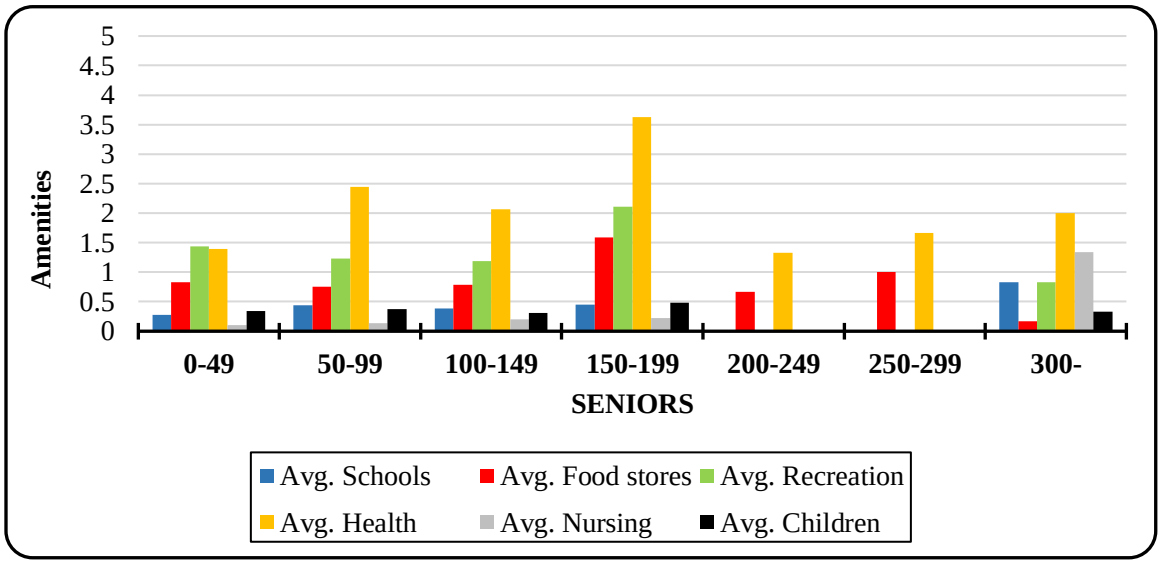


Figure A.32. Amenities per DA (by type) for different concentrations of seniors (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

In Figure A.33, the low-income population is plotted against average amenities per DA and by type of service. DAs with higher concentrations of low-income residents (150 to 249 residents per DA) enjoy the highest number of amenities, health and recreational amenities as well as schools and food stores are in more abundance than in DAs with higher numbers of children and youth. The highest average number of recreational amenities (3.26 facilities per DA) are found in DAs with 0 to 49 children and youth. In this range, health amenities are also highly abundant, at 5 per DA, while accessible food stores average 1.49 establishments. Schools and child care services are also at their highest, with 0.71 and 0.72 amenities per DA, respectively. As the population aged 0 to 14 increases, every type of amenity declines, with the exception of recreational, health and childcare amenities, which show higher numbers in DAs with more than 300 children and youth.

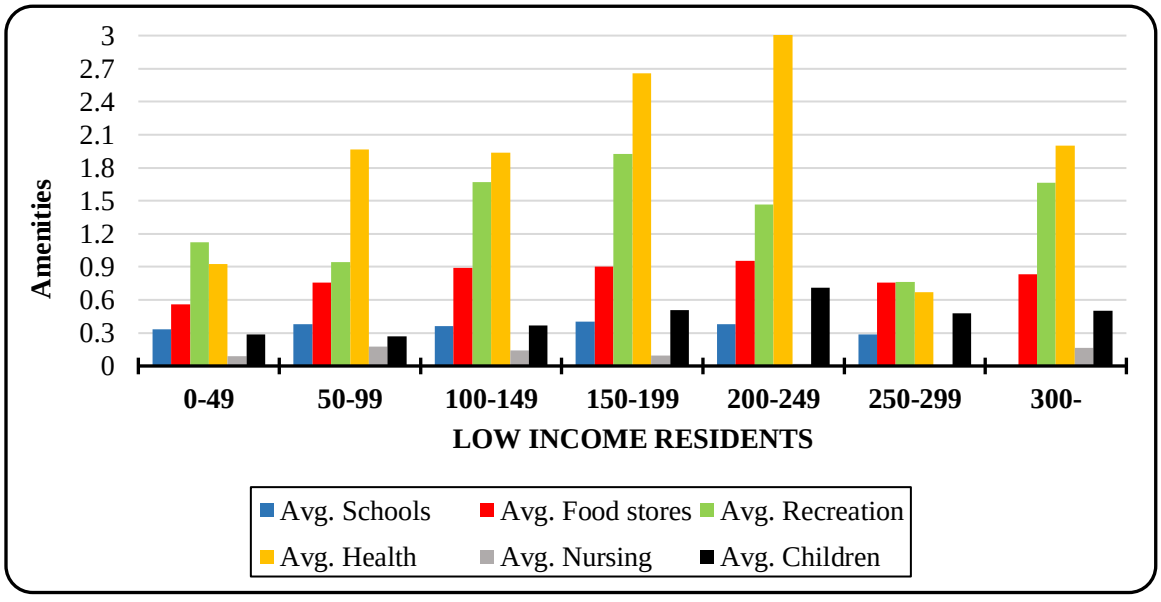


Figure A.33. Amenities per DA (by type) for different concentrations of low-income residents (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

In Figure A.34, ranges of population of drivers are plotted against average amenities per DA for each type of amenity researched in this study. It can be discerned from the graph that, in DAs with higher number of drivers, there are much less accessible amenities for all types. The highest average number of recreational amenities (5.10 facilities per DA) are found in DAs with 50 to 99 drivers. In this range, health amenities are also highly abundant, at 5.19 per DA, while accessible food stores average 1.92 establishments and child care services average 1 amenity per DA. Schools are most accessible in DAs with a 100 to 149 drivers (0.84 schools per DA), where nursing care facilities are most accessible in DAs with 0 to 49 drivers. As the population of drivers increases, every type of amenity declines.

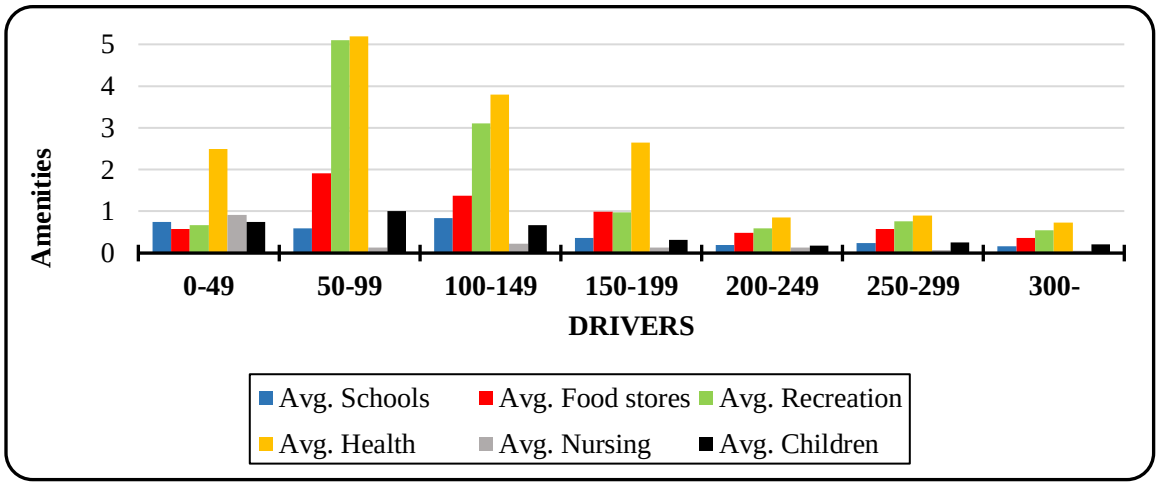


Figure A.34. Amenities per DA (by type) for different concentrations of drivers (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)

In Figure A.35, ranges of population of non-drivers are plotted against average amenities per DA for 6 types of amenities. It can be discerned from the graph that, in DAs with 100 to 149 non-drivers, residents have the highest average number of health (6.28) and recreational (8.2) amenities, as well as food stores (2.67) and childcare amenities (1.13). Higher concentration of non-drivers at the 150-199 range enjoy higher number of accessible schools and nursing care amenities.

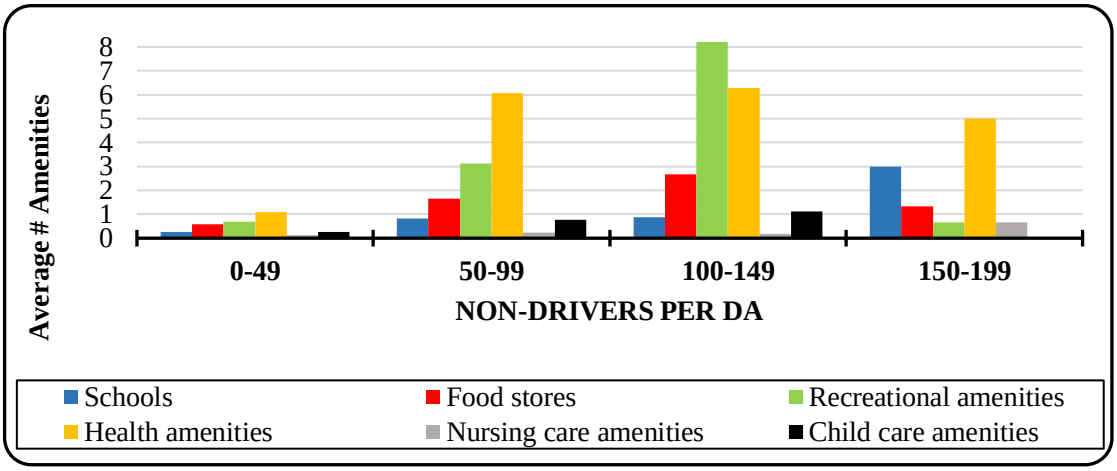


Figure A.31. Amenities per DA (by type) for different concentrations of non-drivers (Source: ESRI, 2015; InfoCanada, 2010; Statistics Canada, 2008; 2007a)